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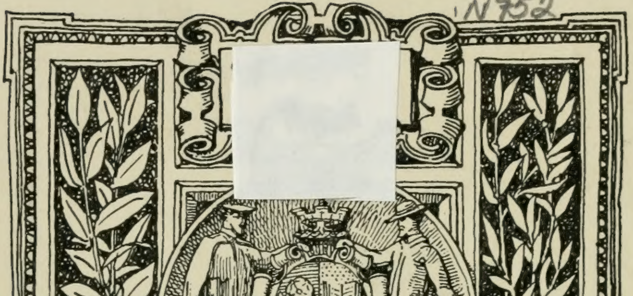

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TWENTY-FIFTH ANNUAL REPORT

OF THE

New York State College of Agriculture

AT

CORNELL UNIVERSITY

AND THE

Agricultural Experiment Station

Established under the Direction of Cornell University

ITHACA, N. Y.

1912

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STATE OF NEW YORK

No. 29

IN ASSEMBLY

JANUARY 15, 1913

TWENTY-FIFTH ANNUAL REPORT

OF THE

New York State College of Agriculture at Cornell University and the Agricultural Experiment Station Established under the Direction of Cornell University

STATE OF NEW YORK

DEPARTMENT OF AGRICULTURE

ALBANY, *January* 15, 1913

To the Honorable the Legislature of the State of New York:

In accordance with the provisions of the statutes relating thereto, I have the honor to transmit herewith the Twenty-fifth Annual Report of the New York State College of Agriculture at Cornell University, as a part of the Twentieth Annual Report of the Commissioner of Agriculture.

CALVIN J. HUSON

Commissioner of Agriculture.

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AGRICULTURAL EXPERIMENT STATION

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CLYDE E. LEIGHTY, B.A., Plant-Breeding.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

November 20, 1912

The Governor of the State of New York,
Albany, N. Y.

The Secretary of the Treasury,
Washington, D. C.

The Secretary of Agriculture,
Washington, D. C.

The Commissioner of Agriculture,
Albany, N. Y.

The Act of Congress, approved March 2, 1887, establishing Agricultural Experiment Stations in connection with the Land Grant Colleges, contains the following provision: "It shall be the duty of each of said stations, annually, on or before the first day of February, to make to the Governor of the State or Territory in which it is located, a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said Commissioner of Agriculture, and to the Secretary of the Treasury of the United States."

And the Act of the Legislature of the State of New York, approved April 12, 1906, providing for the administration of the New York State College of Agriculture at Cornell University contains the following provision: "The said University shall expend such moneys and use such property of the State in administering said College of Agriculture as above provided, and shall report to the Commissioner of Agriculture in each year on or before the first day of December, a detailed statement of such expenditures and of the general operations of the said College of Agriculture for the year ending the thirtieth day of September then next preceding."

In conformity with these mandates I have the honor to submit on behalf of Cornell University the accompanying report.

Respectfully submitted,

T. F. CRANE,

Acting President of Cornell University.

REPORT OF THE DIRECTOR OF THE NEW YORK STATE COLLEGE OF AGRICULTURE FOR THE YEAR ENDED SEPTEMBER 30, 1912

To the President of the University:

SIR.—The activities of the College of Agriculture are increasing in every direction, due to the entrance of a greatly increased number of students and also to the demand for extension and welfare work from all parts of the State. The people seem now to understand the institution and they are making use of it freely. With the staff at our disposal we are unable to meet the spontaneous demands of the people for aid in agricultural and rural problems. This widespread voluntary demand is one of the indications of the rapidly growing interest in country-life affairs, and this interest is one of the important phenomena of the time. The redirection of rural affairs is now well begun and the reconstructive process may be expected to continue until a new understanding and realization of the economic, social, and educational conditions in the open country become well known to all the people.

REGISTRATION

The total registration for 1910–1911 was 1,451, including 128 in the Summer School. The 1,323 registered that year outside the Summer School is to be compared with 1,779 registered in the year 1911–1912. These and the following figures include only students who are matriculated in the College of Agriculture, and do not number those in other colleges in Cornell University who may be taking more or less agricultural work.

In October, 1912, the total registration in the College of Agriculture had reached 1,188, distributed as follows:

Freshmen	360
Sophomores	307
Juniors	221
Seniors	163
Specials	137
	1,188

The above registration may be divided as follows:

Old students	698
New students	490
Total	1,188

Aside from the above undergraduates, there were registered in October, 1912, post-graduates to the number of 107, making a total registration of graduates and undergraduates at the beginning of the college year of 1,295. This number will be considerably increased by the entrants at the beginning of the second half-year.

Aside from the above, the number of winter-course students promises to be large, and the Summer School for the year is yet to be held. The total registration in the College of Agriculture for the year 1912–1913 will probably be much in excess of 2,000 students.

The total registration of 1,779 for the college year 1911–1912 was distributed as follows:

Graduate students		119
Regular students:		
Seniors	123	
Juniors	159	
Sophomores	202	
Freshmen	322	
		806
Special students		180
Winter-Course students:		
General Agriculture	199	
Dairy Industry	93	
Poultry Husbandry	68	
Horticulture	58	
Home Economics	33	
		451
Summer School students		223
Total		1,779

Number of women in regular course	101
Number of women in special course	22
Number of women in winter-courses	58
Total	181

The total registration in the College of Agriculture from the foundation to the present time, so far as we have been able to determine it from our permanent record cards, is as follows:

Former students	5,414
Students now registered	1,188
Total	6,602

If a college of agriculture of these proportions is to be maintained, the State must provide larger facilities in the way of buildings and equipments and also a largely increased maintenance fund. It is a question now either of restricting the registration to much lower figures than we already have, or else of increasing the staff and facilities sufficiently to handle the increasing work with satisfactory effectiveness. It is now impossible to house the agricultural students in the buildings of the College of Agriculture, and some of the classes are held in other buildings of Cornell University not belonging to the State.

EXTENSION AND INVESTIGATION

The activities of the College run along the three lines of research, regular teaching, and extension. The extension work is the natural and necessary outcome of the other two, in an institution supported by the people. The backbone of the College is necessarily the regular teaching, or academic, work, and the first obligation is to provide the best possible instruction to the students who come to it. Education by means of agriculture and country-life subjects should be as sound and as effective as education by any other means. The nature and the aims of regular academic work are well understood and do not need explanation or exposition, but the ideas that underlie extension work in agriculture may be put on record, now that special appropriations for such work have been made by the Legislature.

Extension

1. Extension work in agriculture comprises all educational efforts prosecuted at the homes and on the farms of the people, and also such work at the institution itself — as the winter-courses — that is more or less temporary and that centers chiefly in interests away from the College. Extension work is welfare work, and it is properly a necessary part of an institution that is maintained by the people for the service of the people. Good extension work will develop many local agents and agencies directly in the communities themselves.

Acceptable extension teaching in agriculture is possible only when it is the expression and result of good teaching and good research at home.

The material should be as alive, as personal, and as sound (so far as it goes) as the material of any other teaching; and extension teaching is as much worth doing on the part of the teacher as any other teaching. The extension effort, therefore, must be an organic part of the institution, issuing from it naturally, and taking to the people such part of its findings and outlook as they can usefully apply.

The College of Agriculture is maintained in good part by the State for the benefit of the people of the State, and it must serve the people in every way that it can serve them effectively. The College is attacking the problem of rural civilization.

2. The extension work should be in charge of an extension staff. An extension staff should be as well trained for its work as another staff is trained for regular teaching or for research. The members should be paid as well as members of other staffs. These persons should be students by nature. They must keep up with the best scientific work in their fields, and all of them should have opportunity to make tests, experiments, and studies of their own. If a person is to impart much, he must acquire much.

3. In the organization of the work, each department in the College that deals with agricultural subject-matter should undertake extension work as far and as rapidly as possible, to the end that the department may completely serve the particular interests of the State that it represents. The extension work in the subject-matter in these departments should be in charge of the departments themselves; and the funds for this departmental work should be appropriated directly to the departments.

4. There should also be an Extension Teaching Department in the College, to administer all extension work that is not strictly departmental (that is not a part of the regular departments of the College); and it should aid all departments, so far as it can, in the extension of their special work and make recommendations to them; and it should make recommendations to the Director as to the most advantageous distribution of extension monies in the College. The Extension Teaching Department will have certain functions that are peculiarly its own, such as the administering of itinerant and traveling schools, outside lecture courses, work at the fairs, delegations and excursions coming to the College, reading-courses, correspondence courses, management of resident or local agents, farmers' week and similar enterprises, mailing-room extension, experimenters' league, welfare work in the communities, general publicity and helpfulness of the College of Agriculture to the people of the State.

At the College itself, the Extension Department should give regular instruction, at least for the time being, in the training of students in public speaking, in parliamentary practice, and in extension projects and methods.

Investigation

It is of course well understood that experiment and research are essential to any college of agriculture, and therefore the subject hardly need be discussed here. It may be well, however, to call attention briefly to the experiment station work. The Cornell University Agricultural Experiment Station is established on the two Federal Experiment Station Acts, the Hatch Act, 1887, and the Adams Act, 1906. As early as 1879, however, an experiment station was established at Cornell University, but it was not supported by public funds.

Research is the discovery of truth for the sake of truth. The results and the spirit of research are indispensable to teaching. Agriculture is not to be taught from books or from tradition, but from the facts and principles that underlie the best practice. A good part of the scientific basis of agriculture is yet unknown. The most careful investigation is needed to discover these facts and principles. All good teaching must be founded on this discovery. It is not possible to have the best education if investigation is entirely separate from teaching. The teacher must have the incentive, the spirit, and the new knowledge that come from original inquiry, and the students must be in actual contact with active investigational work. The whole spirit of a college of agriculture is to investigate and to apply.

As a matter of administration, it is not possible wholly to separate the three lines of experiment, teaching, and extension into staffs or faculties. But there should be some officers that function chiefly as experimenters and others chiefly as extension workers. If the staff is sufficiently large and the various lines of work are properly organized, there is little danger that the specialists will be drawn off from their special problems by the developing of all kinds of work coincidently in a college of agriculture. This does not imply that every investigator shall actually be a teacher, for it is best for research that certain persons give all their time to it. Experiment work may be completely divorced from teaching, but teaching cannot be divorced from experiment. It is well, in other words, to have endowed chairs of research in a college of agriculture. The example of such endowed research is of itself worth while also to the teaching side. At the New York State College of Agriculture there are three lines of work endowed specially for research (on the Federal funds) — soils, economic entomology, plant-breeding. All other departments dealing with agricultural subject-matter are expected to engage in research and experiment so far as they may have time and means, and the officers engaged in such investigation are by that fact members of the experiment station staff.

THE PRINTING AND PUBLISHING BUSINESS OF THE COLLEGE

The College is now publishing semi-monthly Lessons in the Reading-Courses, a monthly Rural School Leaflet, bulletins of the Experiment Station, and circulars of the Experiment Station.

In the last year we also established a new publication known as the "Announcer of the College of Agriculture." This is published monthly, and contains brief announcements or statements of the work that the College is doing. This publication has been of more service to the work than any other single innovation that has been made for some time. It enables us to keep the people informed of the activities of the institution that they support, and it is the readiest and most economical means of answering many routine questions. Some of the issues are devoted chiefly to particular topics. One issue, for example, is given to exposition of the experiment station work; another to the extension work; another to the summer school work; others to the new plans for home economics and poultry buildings; and the like. Brief advance abstracts are given of the various publications. The first issue of the Announcer was published in October, 1911. It has already become an established factor in the work of the institution.

The editorial work in the College has now assumed large proportions, as the following summary indicates:

Summary report on editorial work

October 1, 1911 — September 30, 1912

	Total number	Total pages	Copies printed
Experiment Station bulletins	18	752	379,500
Experiment Station circulars	1	4	6,000
Reading-Course for Farm	12	228	341,000
Supplements to Reading-Course for Farm	(12)[3]	48	(341,000)[2]
Reading-Course for Farm Home	12	340	360,000
Supplements to Reading-Course for Farm Home	(12)[3]	32	(360,000)[2]
Rural School Leaflets	4	258	290,000
Supplements to Rural School Leaflets	1	4	25,000
			5,000[1]
Announcers	12	54	669,000
Supplement to January Announcer	(1)[3]	2	(35,000)[2]

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[1] Additional copies of supplement to September, 1911, leaflet, ordered printed January 8, 1912.

[2] Not included in grand total of copies printed, as printed with the bulletins.

[3] Not counted in grand total number of separate publications issued.

	Total number	Total pages	Copies printed
Annual Reports	2	2,556	4,215
Directories and Announcements of Courses	7	199	42,700
Bulletins handled during September, to be printed after September 30	4	92	... .
Circulars handled during September, to be printed after September 30	1	4	....
Grand totals	74	4,573	2,122,415
Plus supplements omitted, as indicated above	25	......	736,000
	99	......	2,858,415

Total pages read, including all manuscripts and proofs=8,725= average of 28 pages per day for every working day in twelve months.

74 publications in 12 months (52 weeks)=1.4 publications, average per week.

2,122,415=176,868 per month=40,816 per week for mailing room to handle.

279 separate batches of manuscripts and proofs handled in 307 working days.

FARMERS' WEEK

The Farmers' Week convention has now come to be one of the most important pieces of extension work that the College of Agriculture undertakes. The Week becomes an assembling place for a number of state organizations, a conference occasion for persons interested in all phases of country life, and a general forum for the discussion of rural questions not only in their technical but also in their general economic, social, religious, educational, and sanitary aspects. Farmers' Week has become important enough to have distinct relation to the processes of state welfare. In order that the full drift of the Farmers' Week enterprise may be understood, I am submitting herewith the programs as conducted at the last series, February 19–24, 1912:

Section I. Lectures and Demonstrations

Monday

9:00 A. M.

Professor H. H. Wing.—Treatment of cows before, during, and after parturition. Animal Husbandry 112.

Professor E. S. Savage.—Feeding dairy calves. Auditorium.

Machinery exhibit. Farm Mechanics building. See p. 24.

10:00 A. M.

Professor H. W. Riley.— Gasoline engines. Main 292.

Professor E. O. Fippin.— Soil moisture, its storage and preservation. Agronomy 152. Repeated Thur. 9.

Professor E. R. Minns.— Soy beans: varieties and culture. Agronomy 192. Repeated Thur. 12.

Rural school education. Rural Schoolhouse. See p. 23.

Conveyance to barns for party of twenty. Leaves Animal Husbandry building daily.

11:00 A. M.

Professor H. E. Ross.—Testing milk and its products for butter-fat. Dairy 222.

Dr. G. F. Warren.— Ways of starting farming with small capital. Main 292. Repeated Thur. 12.

Rural school education. Rural Schoolhouse. See p. 23.

Conveyance to barns for party of twenty. Leaves Animal Husbandry building daily.

12:00 M.

Professor E. G. Montgomery.— Principles of crop production. Dairy 222.

Professor Walter Mulford.— Our forestry problem. Main 292.

2:00 P. M.

New York State Drainage Association. Dairy 222. See p. 18.

Dr. W. M. Wilson.—Weather forecasting by the United States Weather Bureau. Main 292.

Professor H. W. Riley.— Septic tanks for sewage disposal. Main 392. Repeated Thur. 9.

Regular class exercise in judging cows. Judging pavilion.

Lua A. Minns.— Demonstration: The propagation and care of house plants. Greenhouse building, lower floor.

Rural school education. Rural Schoolhouse. See p. 23.

Conveyance to barns for party of twenty. Leaves Animal Husbandry building daily.

3:00 P. M.

New York State Drainage Association. Dairy 222. See p. 18.

Professors G. W. Herrick and C. R. Crosby.— Insect pests of the apple. Main 392. Repeated Fri. 10.

Professor J. L. Stone.—The potato crop. Main 292. Repeated Sat. 11.

Lua A. Minns.— Demonstration: The propagation and care of house plants. Greenhouse building, lower floor.

Rural school education. Rural Schoolhouse. See p. 23.

Conveyance to barns for party of twenty. Leaves Animal Husbandry building daily.

4:00 P. M.

New York State Drainage Association. Dairy 222. See p. 18.

Professor M. F. Barrus.— Grain smuts: their nature and treatment. Main 292.

Lua A. Minns.— Demonstration: the propagation and care of house plants. Greenhouse building, lower floor.

7:30 P. M.

Regular meeting of Round-Up Club. Animal Husbandry 212.

8:00 P. M.

Winter-course prize speaking contest. Auditorium.

Winter-course debate for the Morrison trophy.

Music by winter-course students.

New York State Drainage Association. Dairy 222. See p. 18.

David M. Dunning.—The relation of land drainage to rural public policies. Under auspices York State Country Bond.

Tuesday

9:00 A. M.

R. D. Anthony.—The problem of the neglected orchard. Main 202.

New York State Vegetable Growers' Association. Main 201. See p. 22.

W. F. Hallauer.— Report on transportation conditions in New York.

W. R. Cobb.— Greenhouse construction. Illustrated. Main 292.

Homemakers' Conference. Main 392. See p. 19.

Professor Martha Van Rensselaer.—What the college offers to women.

Dr. G. F. Warren.— Farm layout. Dairy 222. Repeated Thur. 10.

Dr. D. H. Udall.— Veterinary hygiene. Animal Husbandry 112.

New York State Drainage Association. Auditorium. See p. 18.

Rural Church Conference. President Geo. B. Stewart presiding. Main 302. See p. 21.

Professor F. A. Starratt.—The country church: a statement of conditions.

10:00 A. M.

Annual meeting of Dairy Students' Association. Dairy 222. See p. 20.

E. S. Guthrie.— Making butter on the farm. Dairy 202.

New York State Drainage Association. Auditorium. See p. 18.

Professor H. H. Wing.— Lecture on breeds. Animal Husbandry 112. Repeated Thur. 10.

Professor R. L. Watts.—Asparagus. Main 292. See p. 22.

Professor Helen B. Young.—The modern farm house. Main 392.

Professor G. W. Herrick.— Insect pests of peaches, pears, etc. Agronomy 152.

Professor John Bentley, Jr.—The planting of forest trees. Agronomy 152.

Demonstrations in poultry husbandry. Greenhouse building, second floor. Repeated daily.

L. M. Hurd.— Killing and picking poultry.

E. W. Benjamin.— Grading eggs for market and for hatching.

Rural school education. Rural Schoolhouse. See p. 23.

Reverend Silas E. Persons.—What service shall the country church render? Main 302.

11:00 A. M.

Dairy Students' Association. Dairy 222. See p. 20.

W. W. Fisk.— Making fancy cheese on the farm. Dairy 202.

New York State Drainage Association. Auditorium. See p. 18.

Professor M. W. Harper.— Feeding for beef production. Animal Husbandry 112.

Lloyd S. Tenny.—The grading and packing of fruits. Main 202. Repeated Thur. 11.

Professor John Craig.— Progress of nut culture in the United States. Main 292.

Round table on cauliflower. C. H. Aldrich and M. H. Holmwood. Main 201. See p. 22.

Professor H. W. Riley.—The water supply. Main 392. See p. 19.

Professor E. G. Montgomery.— Eradication of weeds. Agronomy 192.

Demonstrations in poultry husbandry. Greenhouse building, second floor. Repeated daily.

W. G. Krum.— Mixing Cornell rations for egg production and for fattening.

R. P. Trask.— Judging poultry for constitutional vigor.

Rural school education. Rural Schoolhouse. See p. 23.

Reverend M. B. McNutt.— Modern methods in country church work. Main 302.

12:00 M.

President J. G. Schurman.—Address of welcome. Auditorium.

W. W. Ware.— Reclaiming muck lands. Main 202. See p. 22.

Professor H. H. Whetzel.—The how, when, and why of spraying. Dairy 222. Repeated Fri. 12.

Professor K. C. Livermore.— Successful types of farming in New York. Main 292. Repeated Thur. 10.

Professor E. R. Minns.— New York State corn varieties. Agronomy 192.

Professor H. N. Ogden.—The condition of health in rural communities. Main 392.

Demonstrations in poultry husbandry. Greenhouse building, second floor. Repeated daily.

E. W. Benjamin.—Testing eggs for market and during incubation.

1:00 P. M.

Dr. H. J. Webber.— Improving the hay crop. Auditorium. Under auspices York State Country Bond.

Conveyance to barns for party of twenty. Leaves Animal Husbandry building daily.

2:00 P. M.

President K. L. Butterfield.—The farmer's task. Auditorium. Under auspices York State Country Bond.

Professor R. L. Watts.— Round table on good seed. Main 201. See p. 22.

Professor M. F. Barrus.— Demonstration: Pear blight. Agronomy 352.

New York State Drainage Association. Dairy 222. See p. 18.

R. H. Stone.— Some figures and facts from a poultryman's experience. Greenhouse building, second floor.

George Frost.— Experiences in developing a poultry farm. Greenhouse building, second floor.

Rural school education. Rural Schoolhouse. See p. 23.

Professor M. W. Harper.— Horse demonstration: Brood mares and colts. Animal Husbandry judging pavilion.

3:00 P. M.

Professor C. S. Wilson.— Round table conference on orchard problems. Main 202.

Professor R. L. Watts.— Round table (to 3:30 p. m.). Main 201. See p. 22.

M. H. Holmwood.— Report on cooperation (at 3:30 p. m.). Main 201. See p. 22.

Professor M. F. Barrus.— Demonstration: Pear blight. Agronomy 352.

Dr. G. F. Warren.— Relation of size of farm to profit. Main 292. Repeated Sat. 9.

New York State Drainage Association. Dairy 222. See p. 18.

L. M. Hurd.— Cornell methods of brooding chickens. Greenhouse building, second floor.

W. G. Krum.— Cornell methods of feeding chickens. Greenhouse building, second floor.

Professor E. G. Montgomery.—Alfalfa: securing a stand. Animal Husbandry 112. Repeated Thur. 11.

Rural school education. Rural Schoolhouse. See p. 23.

Anna B. Comstock.— Some tenants of the farm that do not pay taxes. Main 392. See p. 19.

Dean G. W. Fiske.— Factors that determine the efficiency of the country church. Auditorium.

4:00 P. M.

M. H. Holmwood.— Report on cooperation (continued from 3:30 p. m.). Main 201. See p. 22.

Professor Flora Rose.— Comparative food values. Main 392. See p. 19.

New York State Drainage Association. Dairy 222. See p. 18.

Professor J. L. Stone.— Potato culture. Main 292. Repeated Thur. 4.

Reverend C. O. Bemies.—A constructive program for the country church. Auditorium.

7:30 P. M.

Round table on sheep husbandry. Animal Husbandry 212.

8:00 P. M.

Rural Church Conference. Auditorium.

- Director L. H. Bailey.—The country-life movement.
- President K. L. Butterfield.— What shall the church contribute to the country-life movement?
- Henry Wallace.—The men-and-religion forward movement in relation to country life.

Dairy Students' Association. Dairy 222. See p. 20.

- Professor W. A. Stocking.— Relation of Dairy Students' Association to the dairy interests of the State.
- H. W. Spears.— Condensed milk.
- Frank Zincke.— Market milk.

Carl Thornton.— Certified milk.

H. H. Harriman.— The dairy boys.

Poultry meeting. Main 392.

Professor J. E. Rice.— Recent developments in poultry husbandry.

Mary Yates.—A demonstration in carving poultry. Questions and discussion.

Wednesday

Professor H. H. Wing.— Treatment of cows before, during, and after parturition. Animal Husbandry 112.

Professor E. S. Savage.— Feeding for advanced registry records. Auditorium.

Professor C. S. Wilson.— Fruits for the home orchard and garden. Main 202.

C. H. Myers.— Principles of plant improvement as applied to New York State crops. Main 302. See p. 20.

E. A. Tuttle.— Report on legislation affecting the vegetable grower. Main 201. See p. 22.

Professor H. W. Riley.— Mechanical power for household conveniences. Main 392. See p. 19.

R. O. King.— Greenhouse construction and heating. Illustrated. Main 292.

Professor E. G. Montgomery.—Alfalfa: care of the stand and making the hay. Dairy 222. Repeated Fri. 12.

10:00 A. M.

Students' Association. Professor L. C. Corbett presiding. Auditorium. See p. 21.

Henry Wallace.— The young man in the twentieth century.

Professor M. W. Harper.— Outlook for horse-breeding in New York State. Dairy 222.

Professor U. P. Hedrick.— Pedigreed fruit trees. Main 302. See p. 20.

R. H. Garrahan.— Celery. Main 292. See p. 22.

Rose LeV. Morgan.— Music in the home. Main 392. See p. 19.

S. D. House.—The honeybee and its habits. Agronomy 192.

Dr. G. F. Warren.— Diversified farming on dairy farms. Animal Husbandry 112.

Demonstrations in poultry husbandry. Greenhouse building, second floor. Repeated daily.

L. M. Hurd.— Killing and picking poultry.

E. W. Benjamin.— Grading eggs for market and for hatching.

Rural school education. Rural Schoolhouse. See p. 23.

11:00 A. M.

Students' Association (continued). Auditorium. See p. 21.

Honorable James W. Robertson.—The conservation of life in rural communities.

Director L. H. Bailey.— The college man and the State.

Professor U. P. Hedrick.— The pruning of fruit trees. Main 392.

Dr. H. H. Love.—Corn-breeding. Main 302. See p. —.

Dr. H. J. Webber.— Plant-breeding for the vegetable-grower. Illustrated. Main 292. See p. 22.

S. D. House.— Question box on the honeybee. Agronomy 192.

Dr. W. L. Williams.— Sterility of cows. Animal Husbandry 112.

Professor Martha Van Rensselaer.—Household management. Main 202. See p. 19.

Professor E. O. Fippin.— Lime: its use and effect upon the soil. Dairy 222. Repeated Sat. 10.

Demonstrations in poultry husbandry. Greenhouse building, second floor. Repeated daily.

W. G. Krum.— Mixing Cornell rations for egg production and for fattening.

R. P. Trask.— Judging poultry for constitutional vigor.

Rural school education. Rural Schoolhouse. See p. 23.

12:00 M.

E. S. Guthrie.— Moisture tests and methods of controlling moisture in butter. Dairy 222.

Students' Association (continued). Business session. Auditorium. See p. 21.

New York Plant Breeders' Association. Annual business session. Main 302. See p. 20.

C. W. Waid.— Vegetable crops in the greenhouse. Main 202. See p. 22.

Professor E. R. Minns.— Farm buildings. Agronomy 152. Repeated Sat. 9.

Dr. B. M. Duggar.— The practical value of the root nodules of legume crops and the importance of the full distribution of the nodule bacteria. Main 292.

Reports from Cornell Reading Clubs. Main 201. See p. 19.

8:00 P. M.

General meeting. Auditorium.

Director, Harry Hayward. Address.

C. R. White.— Fundamental principles underlying successful coöperation. Under auspices York State Country Bond.

Music by students.

Thursday

9:00 A. M.

Professor C. S. Wilson.—Varieties and planting plans for the commercial orchard. Main 292.

C. E. Leighty.— Breeding plants for resistance to disease. Main 302. See p. 20.

T. Greiner.— Report: What are the experiment stations doing for the vegetable-growers? Main 201. See p. 22.

Professor H. W. Riley.— Septic tanks for sewage disposal. Main 392. See p. 19.

Professor E. O. Fippin.— Soil moisture: its storage and preservation. Auditorium.

Professor John Bentley, Jr.— Improving the woodlot. Dairy 222.

Professor K. C. Livermore.— Successful types of farming in New York. Agronomy 152.

Professor W. A. Stocking, Jr.— Relation of bacteria to milk. Dairy 222.

10:00 A. M.

H. L. Ayres.— Equipment for the farm dairy. Dairy 202.

Professor H. H. Wing.— Lecture on breeds. Animal Husbandry 112.

Dr. A. W. Gilbert.— Breeding of potatoes. Main 302. See p. 21.

R. H. Garrahan.— Early cabbage. Main 202. See p. 22.

Professor C. F. Hirschfeld.— How to choose a gasoline engine. Dairy 222.

S. D. House.— Hives, fixtures, and manipulation. Agronomy 192.

Professor G. W. Herrick.— Scale insects and the lime-sulfur work. Main 292.

Dr. G. F. Warren.—Ways of starting farming with small capital. Auditorium.

Demonstrations in poultry husbandry. Greenhouse building, second floor. Repeated daily.

L. M. Hurd.— Killing and picking poultry.

E. W. Benjamin.— Grading eggs for market and for hatching.

Ida S. Harrington.— Utensils and their care. Main 392. See p. 19.

Rural school education. Rural Schoolhouse. See p. 23.

11:00 A. M.

Professor M. W. Harper.— Feeding for pork production. Animal Husbandry 112.

Professor Flora Rose.— Imagination in the family dietary. Main 392. See p. 19.

Lloyd S. Tenny.—The grading and packing of fruits. Main 202.

Dr. H. H. Love.— Breeding of wheat and oats. Main 302. See p. 21.

Professor E. O. Fippin.— Onions on muck lands. Main 201. See p. 22.

New York State Rural Engineering Society: Organization meeting. Dairy 222.

Director L. H. Bailey, Professor H. W. Riley, Dean H. E. Cook, S. Fraser, and J. Van Wagenen, Jr.

S. D. House.— Hives, fixtures, and manipulation: question box. Agronomy 192.

Professor E. G. Montgomery.—Alfalfa: securing a stand. Main 292.

Demonstrations in poultry husbandry. Greenhouse building, second floor. Repeated daily.

W. G. Krum.— Mixing Cornell rations for egg production and for fattening.

R. P. Trask.— Judging poultry for constitutional vigor.

Rural school education. Rural Schoolhouse. See p. 23.

Rural Editors' Conference. Agronomy 152.

12:00 M.

Director L. H. Bailey.—Address. Auditorium.

Dr. H. J. Webber.— Breeding of timothy. Main 302. See p. 21.

C. West.— Greenhouse-building for vegetable-growers. Main 292. See p. 22.

New York State Rural Engineering Society. Dairy 222.

Professor E. R. Minns.— Soy beans: varieties and culture. Agronomy 192.

Dr. Lucia S. Heaton.— Personal hygiene. Main 392. See p. 19.

Demonstration in poultry husbandry. Greenhouse building, second floor. Repeated daily.

E. M. Benjamin.— Testing eggs for market and during incubation.

1:00 P. M.

Professor E. G. Davis.— The town center. Auditorium.

R. D. Anthony.— The problem of the neglected orchard. Main 292.

2:00 P. M.

Rose LeV. Morgan. National songs. Auditorium.

Commissioner Eugene Porter.— Some country tools. Auditorium.

C. W. Waid.—Vegetable-growing for the fruit-grower. Main 292. See p. 22.

Jared Van Wagenen, Jr.— Development of small farm water-powers. Dairy 222.

Professor M. F. Barrus.— Demonstration: Apple scab. Agronomy 352.

C. E. Hunn.— Demonstration: Filling window-boxes. Greenhouse building, lower floor.

Dr. F. S. Jones.—White diarrhea and other poultry diseases. Greenhouse building, second floor.

Professor C. A. Rogers.— Discussion on poultry diseases. Greenhouse building, second floor.

Professor M. W. Harper.— Draft-horse demonstration. Animal Husbandry judging pavilion.

Conference: Extension teaching in home economics. Main 392. See p. 19.

Rural school education. Rural Schoolhouse. See p. 23.

3:00 P. M.

Cornell Horticultural Union. Business session. Main 202.

C. W. Waid.—Vegetable-growing for fruit-growers (continued to 3:30 p. m.). Main 292. See p. 22.

H. W. Baxter.— Report on marketing (at 3:30 p. m.). Main 292. See p. 22.

C. E. Hunn.— Demonstration: Filling window-boxes. Greenhouse building, lower floor.

Professor George Young, Jr.— Barn-framing. Dairy 222.

Home Economics students' program. Auditorium. See p. 19.

Professor M. F. Barrus.— Demonstration: Apple scab. Agronomy 352.

Experimenters' League. T. E. Martin presiding. Main 392.

Herbert McLallen.— Cooperation in selling eggs. Greenhouse building, second floor.

Professor J. E. Rice.— Breeding for egg-production: questions and discussion. Greenhouse building, second floor.

S. D. House.— Queen-rearing and bee diseases. Agronomy 192.

Rural school education. Rural Schoolhouse. See p. 23.

4:00 P. M.

H. W. Baxter.— Marketing (continued). Main 292. See p. 22.

Home Economics students' program. Auditorium.

Professor E. O. Fippin.— Soil survey work: what it is, where it has been done, what it shows. Agronomy 152.

C. E. Hunn.— Demonstration: Filling window-boxes. Greenhouse building, lower floor.

Professor J. L. Stone.— Potato culture. Dairy 222.

Experimenters' League. Main 392.

S. D. House.— Queen-rearing and bee diseases: question box. Agronomy 192.

5:00 P. M.

Special organ recital. Sage Chapel.

6:30 P. M.

Horticultural Union banquet.

7:30 P. M.

Round table on Jersey cattle. Animal Husbandry 112.

8:00 P. M.

Honorable Goodwin Brown.— Some home economies. Auditorium. Under auspices York State Country Bond.

Music by students.

Professor G. W. Cavanaugh.—Agricultural chemistry and its relation to soil and fertilizers. Illustrated by chemical experiments. Morse Hall.

Cornell University Poultry Association. Dairy 222.

David Elder.— Lessons from poultry farm surveys.

H. A. D. Leggett.— Recent advances in incubation.

L. A. Dean.— Selling eggs by weight.

O. B. Kent.—What is the relation of the poultryman to cold-storage?

H. A. White.— Cooperative egg association.

Friday

9:00 A. M.

Professor H. H. Wing.— Treatment of cows before, during, and after parturition. Animal Husbandry 112.

Lloyd S. Tenny.— The cooperative marketing of fruits. Auditorium.

Professor A. C. Beal.— Opportunities in floriculture for men and women. Main 292.

Ida S. Harrington.— Kitchen short-cuts. Main 392. See p. 19.

Dr. G. F. Warren.— Cost accounting. Dairy 222.

10:00 A. M.

L. G. Robinson.— Cooperative credit unions. Auditorium.

Professor W. A. Stocking, Jr.— Results of three years' records of dairy cows. Dairy 222.

George Arnold.— The aster and its culture. Main 202.

Professors G. W. Herrick and C. R. Crosby.— Insect pests of the apple. Main 292.

Olive S. Watson.—Artificial indigo: its uses in modern dyestuffs. Main 392. See p. 20.

Professor E. O. Fippin.— Home-mixed fertilizers and their calculations. Animal Husbandry 112.

Demonstrations in poultry husbandry. Greenhouse building, second floor.
  L. M. Hurd.— Killing and picking poultry.
  E. W. Benjamin.— Grading eggs for market and for hatching.

Rural school education. Rural Schoolhouse. See p. 23.

11:00 A. M.

J. W. Pincus.— Cooperative purchasing. Auditorium.

W. W. Fisk.— Methods of selling milk from the farmer's standpoint. Animal Husbandry 112.

M. C. Burritt.— Business methods in fruit-growing. Main 292.

I. S. Hendrickson.— Flowers as field crops. Main 202.

Dr. Lucia S. Heaton.— Personal hygiene. Main 392. See p. 20.

Professor E. R. Minns.— Pastures. Dairy 222.

Rural school education. Rural Schoolhouse. See p. 23.

Demonstration in poultry husbandry. Greenhouse building, second floor.
  W. G. Krum.— Mixing Cornell rations for egg production and for fattening.
  R. P. Trask.— Judging poultry for constitutional vigor.

12:00 M.

Arthur Cowee.— The gladiolus as a special crop. Illustrated. Main 292.

Professor D. Reddick.—The how, when, and why of spraying. Auditorium.

Professor E. G. Montgomery.—Alfalfa: care of the stand and making the hay. Dairy 222.

Anna B. Comstock.—What women can learn from bee-keeping. Main 392.

Demonstration in poultry husbandry. Greenhouse building, second floor. E. W. Benjamin.—Testing eggs for market and during incubation.

1:00 P. M.

Professor H. W. Riley.— Hydraulic rams. Main 292.

Professor J. L. Stone.— Clover-growing fundamental to good farming. Auditorium.

2:00 P. M.

Dr. V. A. Moore.— Recent investigations concerning the control of bovine tuberculosis. Auditorium.

Lloyd S. Tenny.— Round-table conference on cooperative marketing of fruits. Main 202.

Round-table conference on the home garden. T. Greiner, leader. Main 201.

Professor John Craig.— Opportunities in nut culture in the Northeast. Main 292.

Professor M. F. Barrus.— Demonstration: Grain smuts. Agronomy 352.

Public sale of live stock. Animal Husbandry judging pavilion.

Rural school education. Rural Schoolhouse. See p. 23.

Conference: Extension teaching in home economics. Main 392.

3:00 P. M.

Rose LeV. Morgan.— Lecture-recital. Auditorium.

Professor E. O. Fippin.— Recent advances in soil fertility in connection with legumes and other crops. Dairy 222.

Olive S. Watson.— The sulfur colors and other dyeing possibilities. Main 392. See p. 20.

Professor G. W. Herrick and R. D. Anthony.— Demonstration: The making and mixing of insecticides. Farm Mechanics building.

Round-table conference on home garden. Main 201.

Professor M. F. Barrus.—Demonstration: Grain smuts. Agronomy 352.

Rural Bankers' Conference. Agronomy 152.

Rural school education. Rural Schoolhouse. See p. 23.

Tuesday, February 20

Morning session, 9:00 A. M.

Auditorium

The drainage situation on some of the state institution farms. B. B. Robb.

Drainage of clay land. J. Hunter Black.

Chalk talk on drainage. T. E. Martin.

Business session.

Afternoon session, 2:00 P. M.

Dairy 222

The miracle of 300 miles of tile drains. Burt Olney.

Drain tile: what should they be? J. E. Maher.

The part of drainage in the transformation of a clay pit into a productive farm. W. H. H. Rogers.

Earth and stone farm roads and their drainage. W. H. Kelley.

Experimenters' League Annual Meeting

President T. E. Martin presiding

February 22

Main 392

Thursday, 2:00 P. M.

The importance of experimental work to both the home and commercial strawberry-grower. A. B. Katkamier.

Seed-corn selection. L. F. Allen.

Hothouse lambs. W. C. Buell.

Results of some experiments. G. A. Prole.

Report of county work.

Program of the Fourth Annual Meeting of the Homemakers' Conference

February 20–24

Main 392

Tuesday, February 20

9:00 a. m. What the college offers women. Miss Martha Van Rensselaer.

10:00 a. m. A modern farmhouse. Mrs. Helen Binkerd Young.

11:00 a. m. The water supply. Professor H. W. Riley.
12:00 m. The condition of health in rural communities. Professor H. N. Ogden.
3:00 p. m. Some tenants of the farm that do not pay taxes. Mrs. Anna B. Comstock.
4:00 p. m. Comparative food values. Miss Flora Rose.
8:00 p. m. Carving poultry (demonstration). Miss Mary Yates.

Wednesday, February 21

9:00 a. m. Mechanical power for household conveniences. Professor H. W. Riley.
10:00 a. m. Music in the home. Mrs. Rose LeV. Morgan.
11:00 a. m. Household management. Miss Martha Van Rensselaer.
12:00 m. Reports from Cornell Reading Clubs.
2:00 p. m. Preparing poultry for market. Miss Mary Yates.
3:00 p. m. Personal decoration. Mrs. Gratia L. Rice.
4:00 p. m. Library conference in charge of Caroline Webster.
4:00 p. m. Reunion Home Economics winter-course students.

Thursday, February 22

9:00 a. m. Septic tanks for sewage disposal. Professor H. W. Riley.
10:00 a. m. Utensils and their care. Mrs. Ida S. Harrington.
11:00 a. m. Imagination in the family dietary. Miss Flora Rose.
12:00 m. Personal hygiene. Dr. Lucia S. Heaton.
2:00 p. m. National music. Mrs. Rose LeV. Morgan. Auditorium.
2:00 p. m. Conference: Extension teaching in home economics.
3:00 p. m. Home Economics students' program.
8:00 p. m. Some home economies. Honorable Goodwin Brown. Auditorium.

Friday, February 23

9:00 a. m. Kitchen short-cuts. Mrs. Ida S. Harrington.
10:00 a. m. Artificial indigo: its uses in modern dyestuffs. Mrs. Olive Sherman Watson.
11:00 a. m. Personal hygiene. Dr. Heaton.
2:00 p. m. Conference: Extension teaching in home economics.
3:00 p. m. The sulfur colors and other dyeing possibilities. Mrs. Watson.
4:00 p. m. Color and harmony. Mrs. Young.
4:00 p. m. Lecture-recital. Mrs. Rose LeV. Morgan. Auditorium.

Saturday, February 24

9:00 a. m. Household sanitation. Miss Van Rensselaer.
10:00 a. m. The art of furnishing. Mrs. Young.
11:00 a. m. The farm family. Miss Rose.

(The Home Economics laboratory will be open to visitors from one to two and from five to six each day of the week.)

Annual Meeting Cornell Dairy Students' Association

Tuesday, February 20

Dairy 222

Morning session

Address of welcome. Dean L. H. Bailey.
Response. R. E. Clark.
President's annual address. Winfield H. Markham.
Address. Honorable R. A. Pearson.
Business meeting, with election of officers.

Evening session

The relation of the Dairy Students' Association to the dairy interests of the State. Professor W. A. Stocking, Jr.
Condensed milk. H. W. Spears.
Market milk. Frank Zincke.
Certified milk. Carl Thornton.
The dairy boys. H. H. Harriman.

New York Plant Breeders' Association. Fourth Annual Meeting

February 21 and 22

Officers

President — Samuel Fraser, Geneseo, N. Y.
Vice-President — Herbert T. King, Trumansburg, N. Y.
Secretary —Arthur W. Gilbert, Ithaca, N. Y.
Treasurer — George R. Schauber, Ballston Lake, N. Y.

Main 302

Wednesday, February 21

9:00–10:00 a. m. Principles of plant improvement as applied to New York State crops. C. H. Myers.
10:00–11:00 a. m. Pedigreed fruit trees. Professor U. P. Hedrick.
11:00–12:00 a. m. Corn-breeding. Dr. H. H. Love.
12:00– 1:00 p. m. Annual business meeting.

Thursday, February 22

9:00–10:00 a. m. Breeding plants for resistance to disease. C. E. Leighty.
10:00–11:00 a. m. Breeding of potatoes. Dr. A. W. Gilbert.
11:00–12:00 a. m. Breeding of wheat and oats. Dr. H. H. Love.
12:00– 1:00 p. m. Breeding of timothy. Dr. H. J. Webber.

Program of the Rural Church Conference

February 20

Theme: Present-day factors in successful country church work

President George B. Stewart presiding

Main 302

9:00 a. m. A statement of country church conditions. Professor F. A. Starratt.
10:00 a. m. What service shall the country church render? Reverend Silas E. Persons.
11:00 a. m. Modern methods in country church work. Rev. M. B. McNutt.

Auditorium

2:00 p. m. The farmer's task. President K. L. Butterfield.
3:00 p. m. Factors that determine the efficiency of the country church. Dean G. W. Fiske.
4:00 p. m. A constructive program for the country church. Reverend C. O. Bemies.

Auditorium

8:00 p. m. The country-life movement. Director L. H. Bailey.
What shall the church contribute to the country-life movement? President K. L. Butterfield.
The men-and-religion movement in relation to country life. Henry Wallace.
Music by students.

Students' Association of the New York State College of Agriculture. Third Annual Meeting

Wednesday, February 21

Professor L. C. Corbett, Washington, D. C., presiding

Officers

President — L. C. Corbett, Washington, D. C.
Vice-Presidents — H. B. Knapp, Ithaca, N. Y.
R. H. Dayton, East Hampton, L. I.
H. H. Harriman, Syracuse, N. Y.
A. H. White, Ithaca, N. Y.
Sec'y-Treas.—A. R. Mann, Ithaca, N. Y.

Auditorium

10:00 a. m. to 1:00 p. m. The young man in the twentieth century. Henry Wallace.
The conservation of life in rural communities. Hon. James W. Robertson.
The college man and the State. Director L. H. Bailey.
Business session.

6:30 p. m. Reception of present and former students at the Armory.
6:45 p. m. Annual banquet of present and former students of the College of Agriculture. Armory.

On Tuesday, February 20, at 2:00 p. m., President K. L. Butterfield, of the Massachusetts Agricultural College, will speak under the auspices of the Association and of the York State Country Bond on "The farmer's task."

Program of the New York State Vegetable Growers' Association

February 20, 21, and 22

Officers

President — C. R. White, Ionia, N. Y.
Vice-President — M. H. Holmwood, Orchard Park, N. Y.
Secretary — Paul Work, Ithaca, N. Y.
Treasurer — C. H. Aldrich, Mattituck, L. I.

Tuesday, February 20

9:00 a. m.	Transportation conditions in New York. Report of Committee on Transportation. W. F. Hallauer, Chairman. Main 201.
10:00 a. m.	Asparagus. Professor R. L. Watts. Main 292.
11:00 a. m.	Round table on cauliflower. C. H. Aldrich and H. M. Holmwood. Main 201.
12:00 m.	Reclaiming muck lands. W. W. Ware. Main 202.
2:00 p. m.	Round table on good seed. Professor R. L. Watts. Main 201.
3:30 p. m.	Cooperation. M. H. Holmwood. Main 201.

Wednesday, February 21

9:00 a. m.	Report on legislation affecting the vegetable-grower. E. A. Tuttle. Main 201.
10:00 a. m.	Celery. R. H. Garrahan. Main 292.
11:00 a. m.	Plant-breeding for the vegetable-grower. Illustrated. Dr. H. J. Webber. Main 292.
12:00 m.	Vegetable crops for the greenhouse. C. W. Waid. Main 202.
2:00 p. m.	Association afternoon. Main 292. 1. The work of the Association, past and future. Dean L. H. Bailey, President C. R. White, and others. 2. Business session.

Thursday, February 22

9:00 a. m.	Report on what the experiment stations are doing for the vegetable-grower. T. Greiner. Main 201.
10:00 a. m.	Early cabbage. R. H. Garrahan. Main 202.
11:00 a. m.	Onions on muck land. Professor E. O. Fippin. Main 201.
12:00 m.	Greenhouse-building for the vegetable-grower. Chauncey West. Main 292.
2:00 p. m.	Vegetable-growing for the fruit-grower. C. W. Waid. Main 292.
3:30 p. m.	Marketing. H. W. Baxter. Main 292.

Rural School Education

Rural Schoolhouse

Professor M. A. Bigelow presiding

The Rural Schoolhouse will be open from nine to five each day. At 10 a. m. and 2 p. m. special educational topics will be presented for discussion by visiting educators and professors of the University. Subject-matter will be demonstrated by school children. Among other topics the following will be discussed: Agriculture in the high school; agriculture in the grades; gardens; the school and home; manual training; and books.

CONFERENCES AND ORGANIZATIONS

The College is becoming the meeting-ground of many rural organizations and groups that desire to come into touch with the broader aspects of its work and to be in position to reach a growing constituency. Many organizations meet at Farmers' Week, but others convene at other times and are more or less continuous in operation.

I desire specially to mention three organizations or conferences that are now assuming much importance:

Students' Association.—The Students' Association of the New York State College of Agriculture is an organization of all present and former students for the promotion of agriculture and rural betterment. By the organization of local or county branches, it is planned to extend its work through cooperation in the holding of extension schools, cooperative experiments, farm demonstrations, lecture-courses, reading-courses, and the like. An annual meeting is held at Farmers' Week. This Association has become an important factor in the larger work of the College, and this influence will increase through the organization within it of a Committee of Twenty-five to keep in touch with the institution in all its activities.

Rural Church Conference.—The College of Agriculture is interested in all worthy institutions that contribute to the development of country life, and is glad to cooperate with them. There are calls for assistance from rural schools, granges, and other farmers' organizations. Similarly, there has come a demand from rural churches for cooperation in the solution of some of the problems that result from their rural environment. To meet this there is held, in the annual Farmers' Week, a conference of country pastors and rural social and religious leaders of all or any denominations to discuss the questions that particularly affect the work of rural churches. Topics of live interest to rural religious and social workers are presented briefly by persons who have given them special study, after which they are discussed by the conference. Three conferences have so far been held. This year at least twelve hundred persons attended, and the discussion covered a wide range of rural social subjects.

Rural Leaders' Training Conference.— For several years the College has been urged to establish a school for social workers in rural communities. To meet this demand there was held in July, 1911, the first of a series of training conferences of rural leaders. The school lasted for eight days, and consisted of three regular class periods in the morning, two in the afternoon, and one each evening. The subjects considered were the psychology of leadership, the rural mind, rural sociology, the country community and community consciousness, health, education, industry, and socialization. A more advanced course was held the past summer, between Commencement and the beginning of the Summer School. Additional attention was given to the questions of leadership, the country community, and rural sociology, and a new course in rural economics will be added. The Conference is intended for rural ministers, school principals and teachers, editors, secretaries of rural young men's Christian associations, officers of granges and men's brotherhoods, and other active workers who are interested in helping to erect the best human society on the foundation of a good agriculture.

THE WINTER-COURSES

It is often said that the winter-course work will cease to be a part of the College of Agriculture. This is an error. The character of the work will change, but there will always be a strong demand for short terms to enable the people of the State to keep in touch with new facts and forward leadership. The winter-course students will gradually assume the nature of brief-course specials. The greater the extension of agriculture in the public schools, the greater also will be the necessity for brief and more advanced instruction at the College.

Winter-course students are very various in age, preparation, and attainments. The following table exhibits some of these conditions:

STATISTICS OF STUDENTS IN WINTER-COURSES, 1911-1912

	General Agriculture	Dairy Industry	Horticulture	Poultry Husbandry	Home Economics	Totals
Number of men	191	91	56	48	.....	386
Number of women	2	1	12	9	32	56
Number of students from New York State	176	85	52	56	26	395
Number of students from other States	15	6	14	1	3	39
Number of students from foreign countries	2	1	2	.....	3	8
Average age	22	22	26	26	27	24
Nationality:						
Americans	156	78	51	48	25	358
Armenians	......	.....	1	.....	.....	1
Austrians	1	.....	.....	.....	.....	1
Canadians	1	.....	2	.....	2	5
Dutch	......	2	1	1	.....	4
English	8	4	3	2	1	18
Germans	8	1	3	2	1	15

STATISTICS OF STUDENTS IN WINTER-COURSES, 1911-1912 (*continued*)

	General Agriculture	Dairy Industry	Horticulture	Poultry Husbandry	Home Economics	Totals
Nationality (*continued*)						
Irish	3	2	2	.....	.....	7
Japanese	......	.....	.....	1	.....	1
Jews	1	2	.....	2	1	6
Norwegians	1	.....	.....	.....	.....	1
Russians	1	1	.....	.....	.....	2
Scotch	1	.....	2	1	.....	4
South Americans	1	1	.....	.....	2	4
Swedes	3	.....	.....	.....	.....	3
Swiss	1	.....	.....	.....	.....	1
Welsh	2	.....	.....	.....	.....	2
No nationality given	5	1	3	.....	.....	9
Number of college graduates	11	.....	11	1	5	28
Number of students who attended college but did not graduate	12	.....	8	3	2	25
Number of students in winter-courses in agricultural colleges	11	9	20	6	.....	46
Number of normal school students	1	2	1	3	3	10
Number of theological seminary students	......	.....	1	.....	.....	1
Number of military academy students	3	.....	.....	.....	.....	3
Number of high school students (all or part of course)	120	37	19	25	19	220
Number of commercial school students	10	4	3	7	.....	24
Number of grammar school students	5	5	.....	2	.....	81
Number of union school students	2	11	2	.....	.....	
Number of public school students	7	5	.....	8	1	
Number of private school students	......	.....	.....	1	1	
Number of graded school students	1	5	.....	.....	.....	
Number of district school students	8	14	2	1	.....	
No school given	2	.....	1	.....	1	4
College degrees:						
A. B.	10	.....	7	1	4	22
Ph. B.	......	.....	.....	.....	1	1
B. S.	......	.....	4	.....	.....	4
Phar. G.	1	.....	.....	.....	.....	1
Number of students who have had practical general farm experience	167	76	42	28	.....	313
Number of students who have had no practical general farm experience	23	9	18	21	....	71
Number of students who did not state their practical general farm experience	3	7	8	8	32	58
Number of students who have had practical experience in the field of work for which they are registered	167	69	48	34	15	333
Number of students who have had no practical experience in the field of work for which they are registered	23	16	16	18	9	82
Number of students who did not state their practical experience	3	7	4	5	8	27
Number of students who are married	10	11	2	6	10	39
Number of students who are unmarried	183	81	66	51	22	403

MEANING OF THE HERDS AND FLOCKS

Live-stock is kept at the College primarily for instruction and for illustrative purposes. It is also used for experimental work. So far as possible, the various herds and flocks are maintained by breeding rather than by purchase, it being the aim constantly to improve the condition of the herd by selection and careful increase and development. In this regard, notable advance has been made in the productive capacity of the dairy herd and in the quality and weight of the swine. The breeding stud of horses and the flocks of sheep have only recently been established.

It is aimed to maintain the dairy herd at 50 to 60 producing cows, the capacity of the dairy stable being 54. This means the maintenance of approximately an equal number of young animals to replenish the herd as the older animals drop out. With this number we are able to keep a very good breeding herd of each of the five leading breeds of dairy cattle — Holstein, Jersey, Guernsey, Ayrshire, and Dairy Shorthorns.

The sheep comprise a breeding flock of Rambouillets, Dorsets, and Shropshires, representing the leading types of wool and mutton sheep. It is aimed to maintain each flock at about 25 breeding ewes. In addition, we have an "early lamb flock," which at present comprises individuals of several breeds and of mixed breeding. From this flock the ten earliest ewes produced each year are retained for breeding purposes, in order to establish a uniformly earlier-producing strain.

Our facilities for keeping swine are very limited and it has been possible to keep representatives of only a single breed; but in this breed we have been successful in maintaining a leading position, starting from a single pair of animals about ten years ago from which has been developed a herd of first-grade quality. In this time we not only have maintained the quality of the individuals, but also have maintained, if not actually increased, the prolificacy.

The horses on the farm are kept primarily for labor, but we have established a breeding stud and, although we have had our stallion for two years only, we have had one very good crop of colts.

In addition to these permanent herds and flocks, for illustrative material and for experimental work it is intended to purchase each year, in the future, a carload of steers, a carload of lambs, and a carload of green horses, these to be kept during the winter and to be disposed of in the spring when they have served their purpose for experiment and instruction.

INVENTORY OF GENERAL LIVE-STOCK

I present herewith catalog of the animals in the Department of Animal Husbandry, with approximate inventory values (September 30, 1912):

Horses

1 Hackney stallion
2 Percheron stallions
6 pure-bred Percheron mares
3 pure-bred Percheron yearling colts
1 pure-bred Percheron suckling colt
16 2-year grade colts
2 yearling grade colts
16 work horses of various grades
3 driving horses
1 3-year-old colt
2 2-year-old colts
4 yearling colts
1 team mules

Approximate inventory value, $16,600

Cattle

16 Holstein cows
3 Holstein bulls
12 Holstein heifers
4 Holstein calves
14 Jersey cows
1 Jersey bull
2 Jersey heifers
3 Jersey calves
6 Ayrshire cows
1 Ayrshire bull
2 Ayrshire calves
4 Shorthorn cows
1 Shorthorn bull
1 Shorthorn heifer
2 Shorthorn calves
2 Guernsey cows
1 Guernsey bull
5 Guernsey heifers
1 Guernsey calf
9 grade cows

Total, 90; approximate inventory value, $12,000

Sheep

6 Dorset sheep
10 Rambouillet sheep
10 Shropshire sheep
32 pure-bred Shropshire ewes
46 mixed and grade sheep in early lamb flock
About 75 lambs

Approximate inventory value, $1,400

Swine

2 Cheshire boars
7 Cheshire brood sows
16 Cheshire young sows
40 suckling pigs

Approximate inventory value, $570

MEANING OF THE POULTRY LIVE-STOCK

The poultry flocks are kept primarily for instruction and for investigation. These purposes are considered to be of about equal importance. The flocks provide the laboratory materials with which the faculty and students work; they enable the teacher to apply the principles that are taught and the students to acquire knowledge and skill by contact. The flocks are also of value in providing instruction to the large number of persons who visit the college plant and the poultry farm.

The annual sales from the flocks amount to six or seven thousand dollars. This business provides an opportunity for students to become familiar with the commercial side of poultry farming, from both the productive and administrative sides.

Four to five thousand chicks are reared annually. The stock is reared on the poultry farm at Forest Home. The farm comprises 81 acres. It is devoted largely to clover, alfalfa, mangels, and grain crops, in order to demonstrate a desirable system of rotation for a poultry farm with the object of illustrating, by actual results, that the most profitable and the only permanent poultry husbandry must be based on the keeping of poultry as a part of a regular system of farm cropping, maintaining the fertility and reducing the cost of maintenance.

All the work of hatching, rearing, feeding, and the like, is performed by students or persons who have received instruction in class. The farm is a laboratory for the teaching and "trying out" of as many students as the facilities will permit. The working force, therefore, is frequently changing. The inexperienced persons are constantly taking the places of the experienced, the latter being recommended to positions of greater responsibility.

A breed-testing project will soon be under way. The Poultry Department expects to give important assistance to poultrymen by trap-nesting flocks of fowls that are sent to be tested for prolificacy, quality of eggs, fertility, hatching power, and constitutional vigor. The chicks that are hatched from eggs laid by "qualified" hens are leg-banded and returned to the owners. By making it possible for poultrymen to breed from the most desirable hens, the Department has provided a way by which it is expected that the quality of the poultry in the State will be greatly improved.

The superior laying qualities of certain of the college flocks justify the expectation that similar results can be secured by poultrymen generally, if they practice proper methods of selection, breeding, and care. The most productive hens (three-years records) bred or owned by any agricultural experiment station in the United States or Canada, so far as has been reported, are the following:

	Number	1st year	2d year	3d year	Total
Lady Cornell	3,211	257	200	186	643
Madam Cornell	9,363	245	131	158	534
Cornell Supreme	3,418	242	198	213	653
To September 30, 1912					

3,211 — 3d year ends December 6, 1912.
9,363 — 3d year ends November 24, 1912.
3,418 — 3d year ends December 10, 1912.

The fifteen highest-producing pullets averaged 236 eggs each; best single flock of pullets averaged 182 eggs each per year.

Twenty-nine flocks are used for investigative purposes, the following projects being now under way:

1. The testing of eight methods of feeding fowls.
2. A comparison of close confinement and range for egg-production.
3. Breeding to increase egg-production.

4. Breeding to improve the market quality of eggs.

5. A comparison of natural versus artificial hatching on egg-production, on fertility and hatching power of eggs, and on vigor of stock.

6. The effect of the removal of the thyroid glands on health, production, and reproduction of fowls. (Cooperation with Department of Physiology.)

7. The effect of high-fat and high-protein content of the egg on the strength of chicks. (Cooperation with Department of Agricultural Chemistry.)

8. Methods of keeping eggs for hatching.

POULTRY

Number	September 30, 1912
Ducks, 69 @ $1.50	$103.50
Geese, 31 @ $2.50	77.50
Fowls, 5,063 @ $1	5,063.00
Pheasants, 10 @ $2	20.00
Total value	$5,264.00

The names of the breeds and varieties are as follows:

Fowls

Single Comb White Leghorns
Single Comb Brown Leghorns
Buff Leghorns
Anconas
Black Minorcas
Silver Spangled Hamburgs
Single Comb Rhode Island Reds
Buff Orpingtons
White Orpingtons
Barred Plymouth Rocks
White Plymouth Rocks
Buff Wyandottes
White Wyandottes
Light Brahmas
Silky
Rumpless
Wild Gallus Bankiva male
Buff Cochin Bantams
Cross-bred Barred Plymouth Rock and White Leghorn, for experimental purposes

Ducks

White Pekin
Wild Mallard
Rouen
Indian Runner

Geese

Toulouse

Pheasants

English Ring Neck

DAIRY BUSINESS

The Dairy Department now leases and operates four receiving stations, as follows:

Sage (about 9 miles from Ithaca), North Lansing (about 13 miles from Ithaca), Howlands (about 10 miles from Ithaca), and West Groton (about 16 miles from Ithaca).

The buildings at these stations are rented by the Department, while the equipment is owned by the Department. The Department maintains and operates these stations in order to secure a supply of milk and cream for the instruction work in the dairy business. The capacities of these stations can be seen from the following figures for the fiscal year October 1, 1911, to September 30, 1912:

Sage

Total lbs. milk received	972,000
Total lbs. fat received	43,127
Value of the above	$13,673.58
Number of patrons	38
Number of cows	249

Howlands

Total lbs. milk received	1,116,049
Total lbs. fat received	49,680
Value of the above	$15,659.61
Number of patrons	47
Number of cows	297

North Lansing

Total lbs. milk received	1,645,319
Total lbs. fat received	74,037
Value of the above	$23,443.70
Number of patrons	67
Number of cows	426

West Groton

Total lbs. milk received	936,681
Total lbs. cream received (in addition to milk)	4,372
Total lbs. fat received	45,740
Value of the above	$14,582.40
Number of patrons	50
Number of cows	225

Milk from Department of Animal Husbandry

Total lbs. milk received	375,814
Total lbs. fat received	15,143
Value of the above	$6,057.52

Other local milk received at Dairy Building

Total lbs. milk received	648,724
Total lbs. cream received (in addition to milk)	49,108
Total lbs. fat received	38,703
Value of the above	$12,356.21
Number of patrons	44
Number of cows	(not known)

Cream received from Mekeel's creameries

Total lbs. cream received	107,599
Total lbs. fat received	40,232
Value of the above	$16,840.01
Number of patrons	(not known)

Cream received from Interlaken Elgin Creamery Company

Total lbs. cream received	29,575
Total lbs. fat received	10,321
Value of the above	$4,716.42
Number of patrons	(not known)

The above supplies continue throughout the entire year with the exception of the cream that is bought of Mekeel's and of the Interlaken Elgin Creamery Company, which is bought during the university year, primarily the three winter months, in order to provide sufficient product for all our instruction work. It is not possible for us to know definitely the total number of cows from which we receive products, but it is somewhere between 1,500 and 2,000.

Condensed statement of the commercial work of the Dairy Department for the fiscal year, October 1, 1911, to September 30, 1912:

Total lbs. of butter made	322,740
Total lbs. cheddar cheese made	37,319
Number of cottage cheese made	26,458
Number of club cheese made	632
Number of cream cheese made	2,887

Number of olive cream made	85
Number of pimento cheese made	1,526
Quarts milk handled as bottled milk	156,220
Total amount paid to patrons	$104,446.98
Total amount received from commercial sales	$122,596.36

The prices paid to patrons are based on New York quotations for butter, grade of firsts. During the last few years our prices have always been above this quotation, usually not much above in the summer months, but several cents in the winter when we are most in need of milk for instruction.

The butter is sold chiefly to the Ithaca grocers at 2 cents above New York quotations for extras at the Dairy Department. Cheese prices are also based on New York quotations for "current make." The bottled milk is retailed at 7 cents per quart.

MISCELLANEOUS ACTIVITIES

The foregoing statements and tabulations will give some idea of the complexity and also the extent of an educational establishment for agriculture. The work articulates with so many public and private affairs, touches so many and so varied interests, and is so continuous throughout the year, that the burden on all members of the staff is very heavy. In the single matter of correspondence, for example, the pressure is great and practically uninterrupted. For the year ended September 30, 1912, the Secretary's office of the College wrote somewhat more than 10,000 separate letters, not including circulars. The correspondence in the different large departments of the College is also very heavy, requiring the time of a large force of clerks to attend to the mechanical details. In nearly six months following October 1, 1911, for example, the single Department of Poultry Husbandry had written 4,282 letters in addition to issuing 1,182 form-letters. These various figures are indicative of the correspondence in the College at large. The pieces of mail that are handled by the mailing room, in second-class and other matter, of itself makes a large business; and yet the opportunities for service and the work that needs to be done are little more than touched here and there. The whole problem of rural life is as yet only imperfectly understood, and the means of reaching the situation are still very inadequately developed.

The College now comprises twenty-two teaching departments. At this writing there are thirty-six full professorships, between twenty and thirty assistant professorships, and many instructorships. The total roster, including staff and also helpers of all kinds, is more than two hundred and fifty. None of the departments has yet reached the normal limit of its growth, for the organization is recent and much of the work is novel. The members of the staff are working devotedly and almost without reserve. They should have more assistance and better salaries. Productive intellectual work demands an element of leisure and opportunity for recuperation; and the best leadership requires a buoyant spirit.

In the year ended September 30, 1912, we have added one new and separate full professorship, that of Farm Crops, and Professor E. G. Montgomery of the University of Nebraska has been chosen to the place. Professor Montgomery has had good experience in teaching this subject and in the experimental work underlying it, and he brings to Cornell the best thought and outlook in his field.

We greatly deplore the resignation of Dr. B. M. Duggar, who is to become Research Professor of Plant Physiology at the Missouri Botanical Gardens. As Professor of Plant Physiology, Dr. Duggar has developed a most important piece of work in the College. His contribution has been the direct, able, and decisive work of the man of science, seeking truth for truth's sake, and maintaining the highest standards of scholarship and attainment.

We regret to report the death of John Craig, Professor of Horticulture and head of the Department of Horticulture. Professor Craig had been connected with the College for many years, serving the institution as supervisor of reading-courses, popular public lecturer, and helpful associate, as well as professor in his chosen department. He brought rare personal qualities to the work.

PUBLICATIONS

Aside from the reports of the different departments transmitted herewith in original manuscript, I am submitting the following publications to be contained in the Annual Report to the Commissioner of Agriculture:

A statement of the Courses of Instruction in the New York State College of Agriculture for the year to begin October 1, 1912.

Bulletins of the Experiment Station as follows: 304, Substitutes for Skimmed Milk in Raising Calves, E. S. Savage and G. W. Tailby, Jr.; 305, The Cause of "Apoplexy" in Winter-Fed Lambs, H. H. Wing; 306, Classification of the Peony, L. D. Batchelor; 307, An Apple Orchard Survey of Ontario County, H. M. Martin; 308, The Plum Leaf-Miner, C. R. Crosby; 309, The Production of "Hothouse" Lambs, E. S. Savage and G. W. Tailby, Jr.; 310, Soy Beans as a Supplementary Silage Crop, E. R. Minns; 311, The Fruit-Tree Leaf-Roller, G. W. Herrick; 312, Germination of Seed as Affected by Sulfuric Acid Treatment, H. H. Love and C. E. Leighty; 313, The Production of New and Improved Varieties of Timothy, H. J. Webber; 314, Cooperative Tests of Corn Varieties, E. R.

Minns; 315, Fungous Flora of the Soil, C. N. Jensen; 316, Frosts in New York, W. M. Wilson; 317, Further Experiments on the Economic Value of Root Crops for New York, E. R. Minns; 318, Constitutional Vigor in Poultry, C. A. Rogers; 319, Winter-Flowering Sweet Peas, A. C. Beal; 320, Culture of the Sweet Pea, A. C. Beal; Circular 12, The Chemical Analysis of Soil, E. O. Fippin.

The following Lessons of the Cornell Reading-Course for the Farm: Soil Series No. 1, The Soil: Its Use and Abuse, E. O. Fippin; Poultry Series No. 1, Incubation.-Part I, F. T. Finch; Poultry Series No. 2, Incubation.-Part II, F. T. Finch; Rural Engineering Series No. 1, Knots, Hitches, and Splices, H. W. Riley; Poultry Series No. 3, Feeding Young Chickens, Clara Nixon; Farm Forestry Series No. 1, The Improvement of the Woodlot, Walter Mulford; The Horse Series No. 1, Horse Breeding to Increase the Farm Income, M. W. Harper; Dairying Series No. 1, Practical Dairy Problems, H. E. Ross, E. S. Guthrie, and W. W. Fisk; Fruit-Growing Series No. 1, The Renewal of the Neglected Orchard, C. S. Wilson; Farm Crops Series No. 1, Alfalfa for New York, E. G. Montgomery; Fruit-Growing Series No. 2, The Culture of the Currant and the Gooseberry, C. S. Wilson; Farm Crops Series No. 2, The Rotation of Farm Crops, E. R. Minns.

The following Lessons in the Cornell Reading-Course for the Farm Home: Food Series No. 1, The Care and Feeding of Children.-Part I, Flora Rose; Food Series No. 2, The Care and Feeding of Children.-Part II, Flora Rose; Farm House Series No. 1, Household Decoration, Helen B. Young; Farm House Series No. 2, Household Furnishing, Helen B. Young; Rural Life Series No. 1, Reading in the Farm Home, Martha Van Rensselaer; Farm House Series No. 3, The Laundry, Flora Rose; Rural Life Series No. 2, Cornell Study Clubs, Martha Van Rensselaer and others; Food Series No. 3, Principles of Jelly-Making, N. E. Goldthwaite; Food Series No. 4, The Preservation of Food in the Home.-Part I, Flora Rose; Food Series No. 5, The Preservation of Food in the Home.-Part II, Flora Rose; Food Series No. 6, The Preservation of Food in the Home.-Part III, Flora Rose and others; Farm House Series No. 4, Rules for Cleaning, Mary U. Watson.

The following issues of the Cornell Rural School Leaflet: Vol. 5, Nos. 2, 3, 4; Vol. 6, No. 1.

Copies of the monthly Announcer of the College of Agriculture for the year ended September 30, 1912: October 1911, November 1911, December 1911, January 1912, February 1912, March 1912, April 1912, May 1912, June 1912, July 1912, August 1912, September 1912.

Respectfully submitted,

L. H. BAILEY,

Director New York State College of Agriculture.

STATEMENT OF STATE MAINTENANCE APPROPRIATION, 1911–1912

October 1, 1911		
Appropriation		$225,000 00
Expended as follows:		
Office, printing and administration	$27,501 12	
Salaries	119.112 39	
Dairy Industry Maintenance	11,327 19	
Poultry Husbandry	4,782 25	
Horticulture	3,397 03	
Home Economics	3,207 15	
Pomology	2,876 13	
Plant Physiology	3,613 52	
Farm Mechanics	986 04	
Rural Economy	533 33	
Library	493 45	
Farm Management	1,618 28	
Animal Husbandry	9,939 48	
Plant-Breeding	742 24	
Home Nature-Study	367 63	
Chemistry	683 73	
Drawing	129 60	
Meteorology	118 54	
Forestry	1,594 08	
Entomology	2,496 03	
Plant Pathology	1,943 67	
Farm Practice	11,432 03	
Soil Technology	1,536 71	
Rural Art	757 47	
		211,189 09
September 30, 1912		
Balance to meet purchases and obligations arranged for but not completed for payment to date		$13,810 91

October 1, 1911		
Appropriation for the promotion of extension work	....	$50,000 00
Expended as follows:		
Office and administration	$3,336 50	
Extension teaching	8,990 87	
Salaries	18,184 18	
Reading-Course for the Farm Home	1,690 53	
Soil Technology	2,668 28	
Chemistry	668 23	
Entomology	175 52	
Rural Economy	370 34	
Plant-Breeding	1,097 35	
Farm Practice	659 47	
Animal Husbandry	352 01	
Horticulture	622 41	
Dairy Industry	255 99	
Farm Management	889 32	
Poultry	1,726 62	
Rural Education	958 69	
Plant Pathology	871 59	
		43,517 90
September 30, 1912		
Balance to meet purchases and obligations arranged for but not completed for payment to date		$6,482 10

REPORT OF THE EXPERIMENT STATION FUNDS, JULY 1, 1912

	Received	Expended
Hatch Fund	$13,500 00	$13,500 00
Adams Fund	13,500 00	13,500 00
Expended as follows:	Hatch	Adams
Salaries	$6,588 31	$9,231 06
Labor	2,987 88	2,689 61
Publications	698 05	....
Postage and stationery	1,116 30	160 86
Freight and express	62 08	20 19
Heat, light, water, and power	69 32	....

Chemicals and laboratory supplies	77 54	401 42
Seeds, plants, and sundry supplies	498 06	108 31
Fertilizers	28 50	2 00
Feeding-stuffs	50 00	....
Library	11 10	66 34
Tools, machinery, and appliances	228 61	83 76
Furniture and fixtures	83 35	41 87
Live-stock	175 00	....
Traveling expenses	132 27	51 96
Contingent expenses	27 00	....
Buildings and land	666 63	642 62
	$13,500 00	$13,500 00

March 23, 1912

L. H. BAILEY, *Director, N. Y. S. College of Agriculture, Ithaca, N. Y.*

DEAR SIR.—As per request, I have made a careful examination of the books and records of the above College and would report as follows:

1. The appropriations of the State of New York from October 1, 1910, to March 1, 1912.

2. The Federal appropriations from July 1, 1910, to March 1, 1912.

3. The agricultural and State income from August 1, 1910, to March 1, 1912.

Copies of all vouchers for disbursements pertaining to the above are on file and correct.

The incomes from the departments of Poultry Husbandry, Dairy Industry, Animal Husbandry, Pomology, Horticulture, Farm Practice, etc., agree with the records in the main office, and the treasurer's receipts are on file covering the entire amount so reported.

Respectfully submitted,
(Signed) WALTER B. BUTLER,
Public Accountant.

DEPARTMENT OF FARM MANAGEMENT

TEACHING

There was a total of 168 registrations in different courses during the first term of the past year, and 112 registrations during the second term. A total of 682 hours of instruction was given by the department. Fourteen graduate students were registered. In addition there was a registration of 37 in the Summer School.

INVESTIGATION AND EXTENSION

There are three chief lines of investigation and extension work, as follows: (1) Agricultural surveys; (2) studies of successful farms found by survey work; (3) cost accounting. In addition, some work is being done on farm layout and on other minor problems.

The agricultural survey of 671 farms, in five townships in the northern part of Livingston county, will soon be ready for publication. The tabulation of the survey of 755 farms in Jefferson county will be completed sometime during the coming year. The work on both of these had to be discontinued during the summer because of lack of funds.

During the past summer the survey method has been tested in obtaining data on cost of production. Mr. Thompson obtained records for 223 farms in Delaware county, on the cost of producing milk.

The Department is continuing to study the most successful farms that are found by survey methods. The study includes not only those that are the most successful of all, but also those that are the most successful under special conditions, such as small farms, successful farms with small capital, and successful farms on unfavorable soil types. Successful tenants are studied as they change to new farms and the records of the old farms are obtained under different management. We hope to continue this work permanently. The work is being done by Professor Livermore.

The writer spent six years in keeping cost accounts and each year simplified the methods, until we now have a system that can be used by some farmers. In 1910–1911 five farmers cooperated in this work. This year a complete set of cost accounts is being kept by these methods on 26 farms. Mr. Ladd is in charge of this work, which is now being done in cooperation with the United States Department of Agriculture.

RECOMMENDATIONS

Perhaps the greatest need in the Department at the present time is for one man to devote his entire time to attending meetings and fairs, helping farmers replan their farms, and doing other kinds of extension work.

The greatly increased registration of students in the fall of 1912 makes it important that at least two men be added to the teaching force. Otherwise, there is not time for conducting the survey work. The head of the Department should be free from teaching for at least half of the year, in order to write up the results of survey work. Thus far this work has been done at night and during vacations, but now there is too much to be done in this way.

G. F. WARREN,
Professor of Farm Management.

DEPARTMENT OF FARM PRACTICE AND FARM CROPS

TEACHING

At the close of the college year 1910–1911 the Department of Farm Crops, which previous to that time had been associated with Farm Management, was separated from Farm Management and united with Farm Practice under the designation of Department of Farm Practice and Farm Crops.

Dr. P. J. White, who had charge of the teaching work in farm crops, soon resigned to accept a professorship in Pullman, Washington. Professor E. G. Montgomery, of the University of Nebraska, was engaged to take charge of the teaching of this branch. As Professor Montgomery could not arrive in Ithaca before January 1, 1912, no courses in farm crops were given during the first half-year. During the second half-year 155 students registered for the work, 139 of whom received credit for the course — totaling 514 credit hours. In the Summer School 25 students were registered in Course 3 and 20 students in Course A, giving a credit of 42 teaching hours. (As the Winter-Courses are considered a part of the extension work, the teaching done by this Department in those courses is given under that head.)

INVESTIGATION

The investigative work of the Department continues along the lines mentioned in previous reports, namely: durability of several roofing materials; durability of wire fencing material; the adaptation of various forms of lime for alfalfa-growing; the renovation of pastures; the renovation of depleted land without manure.

EXTENSION

Winter-course students in Agronomy		199
Winter-course students in Farm Structures		45
Extension schools attended		7
Special meetings attended		11
Meetings with county agents		6
Farms visited		84
Cooperative experiments supervised:		
Soy beans	28	
Alfalfa	21	
Winter vetch	8	

Sweet clover	4	
Red clover	4	
Pastures	4	
Corn	2	
		71

The correspondence originating in the office of the Department has amounted to 4,100 letters, and enough letters have been answered for the Extension Department to bring the total up to about 6,000.

THE COLLEGE FARM

The principal activities conducted on the college farm for the season of 1911–1912 consisted of the growing of the following crops:

	Acres	Products (as far as harvest is completed).
Corn	58	387 tons silage
Oats and peas	8	36 tons silage
Oats	34	1,943 bushels
Wheat	4	100 bushels
Timothy Hay	46	318 tons
Clover Hay	60	
Alfalfa	29	102 tons
Rye	4	
Meadow seeding	21	(no nurse crop)
Roots	2	55 tons
Cabbage	0.5	
Soy beans	0.5	
Farm-crops garden	1	
Potatoes	4	1,000 bushels

About 120 rods of tile drain has been installed in Field No. 11. A steel-girder, concrete-floor bridge has been built across Cascadilla Creek on the Ithaca-Dryden town line. More has been done in clearing out the stone from old hedgerows than for several seasons past. This Department has furnished the horse labor, and the Animal Husbandry Department the man labor, for grading around the state barns.

During the year we hauled 809 loads of manure from the city and applied it to the farm lands. We have also hauled to the fields 1,293 loads produced at the college barns.

J. L. STONE,
Professor of Farm Practice and Farm Crops.

DEPARTMENT OF PLANT-BREEDING

TEACHING

The teaching division has continued to make very rapid progress since the last report of the Department. The number of students registered in the different courses was as follows:

Course	Number of students
Plant-Breeding 1	72
Plant-Breeding 2	63
Plant-Breeding 3	55
Plant-Breeding 4	12
Plant-Breeding 5	4
Plant-Breeding 6:	
Ph.D. (Major)	10
Ph.D. (Minor)	11
M.S.A. (Major)	5
M.S.A. (Minor)	6
Plant-Breeding 7 (Seminar)	28
Winter-Course	39

This is the only college department in the United States in which the entire attention of the staff is directed toward instruction and investigation in plant-breeding. As a consequence, many teachers throughout the country look to the staff to set the standard for instruction in this subject. The importance of leadership in this direction will be better understood when it is pointed out that in a study of the present status of plant-breeding instruction in this country (made in February, 1911) it was found that over one thousand students of collegiate grade are pursuing plant-breeding studies in the United States.

In regard to graduate students, the study of the present status of plant-breeding instruction gave registration in the colleges of agriculture as follows: New York, 27; Illinois, 6; Nebraska, 3; Iowa, 3; California, 2; Missouri, Ohio, Minnesota, and New York (horticulture), 1 each. There is an increasing tendency for Cornell graduates to pursue graduate work in plant-breeding. For a time practically all graduate students in this field came to us from other institutions; at present there are 13 Cornell seniors pursuing senior thesis work in plant-breeding, most of whom will continue in postgraduate work.

During the past year, Cornell University has awarded advanced degrees for work done in plant-breeding by graduates who came from the following institutions: Ph.D. (Major): Virginia Polytechnic Institution, Utah Agricultural College, Illinois Wesleyan (2), University of Florida. Ph.D. (Minor): New Hampshire College. M.S.A. (Major): Iowa State College, North Dakota Agricultural College, Kansas State Agricultural College. M.S.A. (Minor): North Carolina College of Agriculture and Mechanical Arts, Massachusetts Agricultural College.

Special attention has been given in this Department in the past year to methods and materials used in teaching graduate and undergraduate courses, in the latter case with reference to laboratory work. The graduate students have undertaken a systematic indexing of articles on genetics in above seventy publications both in this country and abroad. The Department has cooperated with other agencies in the University for stimulating work in genetics. The recently organized Eugenics Club of Cornell University has received much assistance from the Department.

The following articles, written by Professor A. W. Gilbert, have recently been published and are intended to be of assistance to persons teaching the subject:

The Present Status of Plant-Breeding Instruction in the United States. Annual Report of the American Breeders' Association, Vol. VII.

Suggestive Laboratory Exercises for a Course in Plant-Breeding. American Breeders' Magazine, Vol. II, No. 3.

Suggestions for an Undergraduate Course in Plant-Breeding. Annual Report of the American Breeders' Association, Vol. VI.

Another article by the same writer, on graduate instruction in plant-breeding, will soon appear.

Recommendations

The Department wishes to express with renewed emphasis the recommendations of former years. Lack of room greatly handicaps the work, especially the instruction to graduate students. Larger funds should be allotted for the purchase of books with which to build up a department library. The facilities of the university and agricultural libraries are now very inadequate for the use of such large numbers of students as come to us for instruction.

A strong course should be developed in seed-growing and seed-production, with an expert in charge. The seed business of this country has become enormous and some definite instruction should be given here in that line. We have had in our classes in the last few years a large number of young men who have been sent to us from very prominent American seed houses.

A course with special reference to breeding horticultural crops might reasonably be added if sufficient funds could be obtained.

The very large number of graduate students require much more greenhouse space than we have at present. So much research work must be done in the wintertime that much space under glass is required.

INVESTIGATIONS

Experiments in breeding timothy

The timothy-breeding experiments, which have been under way since 1903, are continuing to give very interesting results. During the course of the investigations a large number of distinct varieties, possessing a great many divergent characters, have been isolated. Many of these are of value only from a scientific standpoint, but others apparently possess great value for practical cultivation.

For six years, tests have been made of the comparative yields of different types when grown in rows, and for three years similar comparative-yield tests have been made with 17 new varieties sown broadcast in plats. The possible value of the results obtained are forcibly suggested by the yields of the broadcast plats. In testing these 17 new sorts, they were planted in comparison with check plats sown with the best timothy seed that could be purchased on the market; there being 7 check plats equally distributed among the 17 plats of the new varieties.

The average yield for the check plats for three years was 5,211 pounds per acre. The average yield for the 17 new varieties for three years was 6,667 pounds per acre, which shows an average gain of 1,456 pounds per acre in favor of the 17 new sorts. These figures include all the new varieties. It is obvious, however, that some of the 17 new strains must be superior to others in the production of high yield. This is actually the case, and certain strains — namely, selection numbers 1,611, 1,627, and 1,629 — gave increases of 1,943 pounds, 2,707 pounds, and 2,840 pounds, respectively, over their check plats, thus showing their superiority over some of the other sorts.

In addition to the above plats several other broadcast plats were sown in the fall of 1911 and again in September, 1912, in different parts of the State.

Since some of these 17 new strains gave promise of high yield, it was thought best to plan a distribution of seed to different parts of the State. About seventy-five lots of seed of the best sorts were sent out to farmers in various parts of the State during the fall of 1912, and, in addition to these, seed was distributed to a number of farmers in Jefferson county with whom a cooperative contest had been arranged. This contest will be described more fully under "Extension." It is planned to multiply the seed of these varieties and make a general distribution as soon as possible.

Whenever promising sorts have been obtained they have been planted in isolated beds surrounded by rye or other crops, and grown to produce pure seed. Some of the isolated plats were increased in size during the last year and several new plantings were made of the many different sorts. The new plantings contained both the promising economic strains and those that are kept purely from scientific interest.

In the fall of 1912 several hundred seedling timothy plants from some of the very best strains were distributed to a few farmers in different parts of the State. This had nothing to do with the seed distribution, but was merely an attempt to get the farmers to take up the selection of plants suited to their own farms and conditions.

Corn-breeding experiments

The corn-breeding experiments that are being conducted by this department have been continued as in preceding years. Selection plats of Pride of the North at Aurora, and Funk's Ninety Day at Ballston Lake, have been under observation for five years. A similar selection of Reid's Yellow Dent was conducted for two years at Ithaca and then transferred for two years to Utica. This variety has, in general, proved so late that in 1911 it was transferred to southeastern New York, at Bedford Hills, where it will be further selected and thoroughly tested.

At Bedford Hills an experiment in the selection of Funk's Ninety Day is also being conducted, having been started in 1910 from seed from the plat at Ballston Lake. In fact, the seed from the ears that were used for planting the Ballston Lake plat in 1910 was divided, and part of each ear was planted at Bedford Hills and part at Ballston Lake.

The main object of these experiments is to obtain earlier varieties of corn that will mature seed under New York conditions and will also give a high yield of grain. These different sorts are responding very markedly to the selection for earliness. The effect of selection was well demonstrated in the following manner at the Ballston Lake plat in 1911: A general lot of select seed was obtained by taking a small quantity of seed from each of the ears selected for planting. This was used to compare the gain in earliness by planting it in alternate rows with the original seed with which the selection was started. The original seed used in the test was obtained by mixing kernels from each of the ears planted in starting the selection the first year, 1908. The crop from these alternate rows was harvested and carefully compared with reference to earliness. It was found that in the rows grown from the improved seed 72 per cent of the ears were fully ripe when husked, while in rows grown from the original seed only 13 per cent of the ears were graded as ripe and, in fact, these few were not so ripe as the ripe ears of the improved strain. This degree in ripeness, so far as could be judged by observation, represents a gain of at least two weeks in earliness or time of maturing. During the selection careful attention has also been given to productivity and the early strain remains fully as productive as the original variety.

Fully as striking results in the decrease of the season required to reach maturity have been obtained with the Reid's Yellow Dent, but this variety as yet remains rather late for New York conditions.

In connection with this corn-breeding work it is thought well to determine whether these new strains of dent corn that will mature seed would be of as great value for silage purposes as strains that are later and do not mature seed under New York conditions. With this in mind an experiment was started in 1911 to compare the silage value of these selected sorts with some of the common silage corn. This experiment is to be continued in two places during 1912. It is thought that such a study, for two or three years, will show whether it is possible to obtain an all-purpose variety — in other words, a variety that will be desirable for both silage and grain.

While these breeding experiments have been under way, many notes have been taken on the parent ears to learn, if possible, whether there are any visible seed-ear characters that may indicate high yield or earliness. These experiments have not been completed as yet. Some of the new sorts have reached a stage where it seems that the Department is justified in distributing seed in certain parts of the State, and such a distribution has been planned for 1913.

Cereal-breeding experiments

The cereal-breeding experiments are being conducted in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture, and include at present the breeding of oats and wheat.

Oat-breeding experiments.— The testing of the hybrids and selections made by Professor J. B. Norton, of the Department of Agriculture, has been continued during the past year. The test has now run through six seasons, having been begun in 1907 and continued to date. The yields of grain from the different varieties have been carefully determined each year and it is now possible to draw some conclusions from the results.

For the seasons of 1911 and 1912 the yield of straw has also been obtained, since it seems desirable to have strains that yield large amounts of both grain and straw.

In some cases there is very little indication of the tendency to reproduce high yield, while in others this tendency seems to be very evident. Certain of these strains have given high yields throughout the period of testing, and therefore it seems that these varieties give good promise of being high yielders under New York conditions. There now remains, however, the testing of these strains in comparison with the standard varieties grown in New York. Such a test was begun in 1910. For the years 1910, 1911 and 1912, the average yield of the best ten hybrids was 57 bushels per acre and for the best ten selections was 56.4 bushels per acre, while that for the best eight varieties was 53.1 bushels per acre. This test was conducted in a uniform manner, so that the ordinary varieties (commercial) grew side by side with the hybrids and selections. Since our soil is very ununiform, these varieties were planted in rod rows which were repeated many times through the field, thus placing the different strains on different types of soil. In this way we were able to conduct a very careful test and thus learn the value of the different hybrids and selections.

Another interesting factor brought out in connection with the experiments is the comparison between the yielding capacity of the hybrids and selections.

In 1907 the tests of all hybrids gave an average of 50 bushels per acre, while the average of all straight selections gave a yield of 49.4 bushels per acre. In 1908 the calculated average yield per acre of all hybrids was 55 bushels and of all straight selections 49.3 bushels. In 1909 the average yield of all hybrids was 36.5 bushels per acre, while that of all straight selections was 38.9 bushels per acre. For 1910 the average yield of all hybrids was 64.6 bushels per acre, while that of all selections was 59.9 bushels per acre. For 1911 the average yield of all hybrids was 45.9 bushels per acre, of all selections 48.7 bushels per acre. For 1912 the average yield of all hybrids was 52.5 bushels per acre and of all selections 51.1 bushels per acre. The average for the six years was, for the hybrids, 51.3 bushels per acre and for the selections 49.8 bushels per acre. The averages for the six years show that the hybrids gave a higher yield than the selections, and seem to indicate that, so far as yield is concerned, the hybrids are better, on the average, than the selections.

The data thus far obtained furnish considerable evidence of the value of different classes of hybrids. It would seem that the most promising combinations of those tested for New York conditions are: Burtt crossed with Sixty Day, Garton's Tartar King crossed with Clydesdale, Sixty Day crossed with Probsteier, and Sixty Day crossed with Clydesdale. These conclusions cannot be taken as absolute, since other combinations than those tested might prove to be more promising.

This past year many other commercial varieties of oats were added to those already being tested. This was done in order to determine whether the hybrids and selections were better than some of the commercial varieties already on the market.

About three thousand plants each from several of the most promising commercial varieties were grown during 1912 with the intention of making new selections. These plants were grown one foot apart each way, so that all would have the same cultural conditions, and selections were made from the field.

During the summer of 1911 and the following winter in the greenhouses, many new hybrids were made with the hope that certain other combinations might be found which would prove of value for New York conditions.

In the spring of 1912 seed from some of the best hybrids and selections was sent to several parts of the State, where cooperative tests were to be made comparing these new strains with some good commercial varieties grown locally. The yields from these tests have not all been obtained as yet, but indications are that certain of the strains will prove to be very good for some parts of the State.

The investigation to determine whether it is possible to produce a winter oat suitable for New York conditions is still under way, although results have advanced little in addition to what has been announced in previous reports of the Department. Several individual selections of plants have been tested with the hope of obtaining some good strains that will withstand the winter and give high yields. The main object of this investigation is to overcome low yield due to the fact that because of bad weather in spring many fields have to be seeded very late. Experience has shown that the late sowing of oats, as a rule, gives lower yields than do oats seeded earlier. It is thought that if a winter variety can be obtained, the seeding can be accomplished in the fall as is done with winter wheat, and thus the late spring planting would not so materially affect the yields. It is not possible at present to make any predictions regarding this line of investigation, but results obtained thus far certainly justify its continuance. The winter oats ripened about two weeks earlier than spring oats and were much freer from smut and rust.

In addition to the oat experiments just outlined, for the past two years the Department has been conducting an experiment to determine whether the ordinary method of testing different varieties of oats is the best one to use. In ordinary practice, oats are sown at a certain rate per acre. The number of bushels per acre sown is usually determined by either measure or weight, but, owing to the fact that some strains are large-grained and some small, this method of seeding may give a very different stand for different varieties of oats. With this in mind the same weights per acre were planted, and at the same time the seeds were sown in such a way that the same number of kernels were sown for the different varieties, thus getting nearly a uniform stand. The experiment has not been carried far enough to draw definite conclusions, but so far it is shedding some light on the question and it indicates that the practice of sowing the same amounts of seed per acre may not always be best to follow. This experiment is to be continued.

Wheat-breeding experiments.—The wheat-breeding experiments have been continued in much the same manner as outlined in previous reports, except that fewer varieties have been grown, but more selections of individual plants of the more standard varieties have been tested to a greater extent. Several hundred strains from about a dozen standard varieties have been tested in rod rows, in order to get some comparison of yields between varieties and also between different strains within the varieties.

From the results of these experiments for the last three years it would seem that we have some selections, when tested under uniform conditions, which give promise of much greater yields than the varieties from which they were selected. These selections were made from several well-known varieties of wheat, such as Rural New Yorker, Prosperity, Seneca Chief, Dawson's Golden Chaff, New Soules, Fultz, and various others. During the course of this selection, strains have been isolated that yield three to five bushels per acre more than the varieties from which they were selected, showing the possibilities of selection.

For the years 1911 and 1912 the yield of straw has also been obtained, since the value of straw has become so great that it seems desirable to obtain strains of wheat that will give high yields of both straw and grain.

During 1912 several commercial varieties have been added to our series,.to test further the new strains that we have under trial.

During the summer of 1912 several hundred new head selections were made from some of the more common commercial varieties. These have been planted in the field, with the hope of obtaining some desirable strains for multiplication and distribution. Small amounts of seed of our most promising strains were distributed in four different localities this fall.

A few strains of both wheat and oats have shown that for certain parts of the State they are superior to the commercial varieties, and it seems desirable to multiply these just as rapidly as possible. At present the Department has on hand a considerable quantity of oats which it plans to distribute in 1913, and the best strains of wheat are being increased so that seed of these may also be distributed in 1913.

Potato-breeding experiments

The potato-breeding experiments outlined in previous reports are being continued. The greater part of these investigations is of scientific nature, designed to test in a thorough manner the question of whether improvement can be made by hill selection, or whether differentiations can be obtained within pure-tuber lines. These experiments should ultimately furnish conclusive evidence of the value of hill selection, which is now advocated as a desirable method to pursue in potato-growing. The value of this method has been seriously questioned, and it is highly desirable that definite proof be obtained either favoring or opposing the practice.

Two lines of experimentation are under way on this subject: first, a selection within pure-tuber lines, that is, within a progeny known to have been derived from a single tuber; and second, a practical hill-selection experiment, carried out as a grower might be expected to select hills in improving his crop.

Aside from the above experiments a considerable number of potato seedlings have been grown and tested. Here data are being obtained on the variation of potato seedlings, and observations are being made to determine how soon a definite conclusion may be reached regarding the value of a seedling. It is also hoped that in this experiment some of the numerous seedlings may prove to be valuable sorts for cultivation.

Forage crop investigations

Little advance has been made in the forage crop investigations mentioned in the previous reports of this Department, as the crowding of other experiments has prevented the specialization on these lines of work. Several different strains of brome grass have been isolated and these are being tested to determine what value they may possess as forage plants for New York conditions. Such alfalfa selections as have been made have been interrupted by the failure of the plants to set seed under our conditions. It would seem from the observations thus far made that the first step in any experiment in the improvement of alfalfa for New York conditions must be directed toward strains that will uniformly set seed under those conditions.

The experiments with cowpeas are still under way, and it is believed that early strains which will mature seed in this latitude can ultimately be obtained.

Adams Act research

The work on projects outlined under the Adams Act has been continued in accordance with the plans stated in previous reports. Many interesting results have already been obtained and are being tested as rapidly as possible.

Studies on variation.— In starting the work of this Department in 1907, it was conceived that the most important problem in the field of breeding was to determine what factors influence variations and what can be done to force variations in plants. Variation is important in the starting of any breeding work; in fact, no advance can be made without variation. With this in mind a great deal of work has been conducted in the Department in order to obtain further knowledge on the subject of the production of variation.

The special problems which are being studied under this general heading were stated in previous reports and need not be announced here.

Some experiments to test the so-called Knight's Law, that high feeding increases the range of variation, were conducted by Dr. H. H. Love and have been published in Bulletin 297. A similar series of experiments are being conducted by Dr. C. H. Myers and a part of these results will be published within the coming year.

Some very interesting experiments to determine the effect of temperature changes in producing variation have been conducted for the past three years by Dr. R. J. Evans and A. W. Drinkard. The material used was *Stellaria media* and browallias. The results of this work will probably be published during the coming year.

Another extensive experiment in this same field is a study of the variations in the common oxeye daisy (*Chrysanthemum leucanthemum*), conducted by Dr. H. H. Love. Here a study of the range and amount of variation in different habitats and under cultivation is being made. The variation in the same locality in different seasons, and the change in type from the beginning to the end of the blooming season, are other phases of this problem.

Studies on the laws of inheritance.—The studies of hybrids and the segregation and inheritance of characters are being conducted and extended as rapidly as possible. Doctor Gilbert's experiments with hybrid tomatoes and with phlox are practically completed and are being prepared for publication. Particularly interesting results have been obtained in these experiments on the inheritance of size in tomatoes.

A similar study, which is being conducted on a fairly extensive scale, is in progress with peppers. The pepper furnishes a number of contrasted characters in its numerous varieties, and affords a fine field for the study of problems of inheritance. Such characters as yellow and red color, erect and reversed fruit, presence or absence of chlorophyll in the young fruit, and presence or absence of pungency, segregate and are inherited in Mendelian proportions. The question of bodily characters, such as erect or horizontal branching, large or small branches, has been carefully considered, and it seems that these characters evidently behave in a Mendelian manner.

Another interesting observation in connection with these experiments is the fact that in the third generation of these hybrids many types showing intermediate sizes and forms of fruit are apparently reproducing these intermediate forms true, while by the law of segregation they would be expected to split into the two parental types. The explanation of this phenomenon has not yet been found.

A preliminary paper on these experiments has been published and a detailed report of the results of the experiments will be issued as soon as possible.

Other Mendelian studies are being made with oats, radishes, browallias, morning-glories, and the like, and many data of interest are being accumulated.

Studies on mutations and their use in breeding.— It is obvious that the investigations of mutations must be closely associated with the studies of variations, as at present we know very little regarding the causes of mutations. Among the most important studies of this nature under way are those connected with the timothy-breeding work and the study of variations in the daisy. The striking variations that have been found in timothy, some of which have formed the basis of valuable new varieties, are apparently to be classed as mutations, and careful studies of them are being made to determine what they are. In the timothy work all types of variations are being isolated and studied regardless of their value in order to obtain, if possible, some idea of the nature of the variations. In any case this study will furnish an extended analysis of the characters of timothy and of their combination in different races now existing but mixed indiscriminately in what we know merely as timothy.

A large number of strikingly different types, which are probably to be considered as mutations, have been found to exist in the wild daisy. These have been isolated and plantings made from them. Careful notes are being taken and further plantings made in order to determine whether these different types reproduce their characters as mutations should do, or whether they are merely environmental variations.

Studies on the cumulative action of selection.—The studies on this subject, which are mainly with wheat and oats, are being continued, but as yet there are no results available for publication. Experiments of this nature must be conducted for many generations before any conclusions may be drawn.

Correlation of characters.— One of the very important problems in breeding is to know the interrelations of characters, or the correlation of characters, and much time may be saved in selection work if the relationship existing between different characters is known.

Correlation studies have been made with wheat, oats, corn, peas, and other plants. In each of these crops a considerable number of characters have been noted. Most of these studies have dealt with the relation of certain measurable characters to yield. This has been done in order to determine what characters for the different crops may be used in further breeding work, so that intelligent selection for high-yielding strains may be conducted. Several papers on this general subject, which have been prepared by members of this Department and by graduate students, either have been published or soon will be.

Studies on bud variation.— One of the principal lines of investigation under this heading is that to determine the range or degree of variation in potato families which have been developed from a single tuber and constitute what we may call a pure-tuber line. Many selections of variations in yield, shape of tuber, and the like, within these pure lines, have been made in order to determine whether such visible variations are inherited and whether advance in different directions may be effected through selection.

A knowledge of this subject is fundamental in the practice of the hill selection of potatoes, as mentioned previously in this report, and definite knowledge is very much desired.

EXTENSION

The special fund for the extension work of the Department of Plant-Breeding became available October 1, 1911. At that time it was thought advisable to conduct this extension activity along three lines: first, cooperative and demonstrative work with individual farmers; second, distribution of new varieties of timothy, oats, wheat, corn, and the like; and third, educational activities, such as exhibits, lectures, instruction in extension schools and short courses, special field meetings, and the like. The results of the efforts along these special lines are given in detail below.

Cooperative and demonstration plats

It is believed that the cooperative and demonstrative work with individual farmers is very important. Farmers of the State are becoming alive to the value of well-bred seed. They are beginning to realize that " blood tells " in agricultural crops as well as in agricultural animals, and a large part of the correspondence of this Department consists of requests for improved seed. Very few growers, however, have realized the possibilities of their own individual work in this regard. Therefore it has seemed necessary to conduct a campaign of education by means of cooperative and demonstrative experiments. A comparatively large number of these are well under way.

Among the experiments now started are seven corn-breeding plats and as many potato-breeding plats, distributed in Saratoga, Cayuga, Jefferson, Westchester, Wyoming, Dutchess, Erie, and Orange counties. These plats are being conducted under the personal supervision of this Department. In every instance careful outlines of method have been furnished and these directions have been supplemented by personal visits at important stages of the work.

Other cooperative work is with wheat and oats. This might be considered partly under the distribution of seed, but at the present stage it may be well to consider it here. In the work of the Experiment Station many new sorts or varieties of wheat and oats are obtained. Some of these are superior to the old sorts, so far as their growth on the college farm is considered. The conditions on this farm, however, are not uniform throughout the State. Therefore it is advisable to test these new varieties in other localities. Incidentally, in testing these, the seed is increased so that a beginning may be made in the distribution of the better strains. The experiments also have their value in illustrating the method of the improvement of cereals. There were, during the past season, ten such plats of oats and five plats of wheat planted for the coming year's crop. In all these instances the Department directs the manner in which the plat shall be handled, and also reserves the right to buy the larger part of the seed produced — leaving the cooperator enough, however, to enable him to get a good start in that variety or those varieties which best suit his conditions. These fifteen experiments in oats and wheat are located in Onondaga, Orange, Chemung, Tompkins, Allegany, Madison, Chautauqua, Westchester, Livingston, and Cayuga counties. In addition to the above-mentioned work with wheat, two other special plats are located in Niagara county. In these are being tested, by the head-to-row method, a large number of types of wheat from various sources. The purpose of these experiments is to improve the quality and quantity of wheat grown in the Genesee Valley. The conditions in this region are favorable to the production of the crop, and there is a ready market for wheat of the proper quality at the Shredded Wheat Factory, Niagara Falls. This factory would probably be able to use all the wheat produced in this region, and should not have to bring in grain from other sources. Since the quality of wheat that the company requires — a soft white — is one easily produced in New York State, it would seem that the New York farmer should be able to compete successfully along that line with all others. The number of these experimental plats should be increased, but care needs to be exercised so that not more will be started than can well be supervised.

As is shown earlier in this report, considerable advance has been made in the work of timothy-breeding. As in the case of oats, new and promising varieties have been obtained. These need to be tested under different conditions of soil and climate. Here, too, is the added purpose of increasing the seed so that distributions of varieties adapted to local conditions may be made. There have been conducted during the past year, under the personal direction of the Department, twelve such timothy tests, distributed in St. Lawrence, Madison, Monroe, Livingston, Tompkins, Chemung, Seneca, and Allegany counties. In these tests, also, the Department reserves the privilege of buying the seed produced.

The results of all these cooperative and demonstrative experiments have been very gratifying. Much interest has been taken in them in the communities where they are located. No trouble whatever has been experienced in placing the tests, and the number has been limited only by the seed available and the time necessary for their supervision. During the year just ended, seventy personal visits have been made in the interest of this cooperative and demonstrative work. It is hoped that the number of these experiments may be increased until they include every crop grown in every county in the State.

Distribution of seed

The distribution of new and improved varieties of seed is considered as next in importance, in the work of the extension division of this department. It is not likely that the College will ever be able to grow the seed of any crop in sufficient quantity to allow of its being distributed generally over the State. Hence it becomes necessary to distribute seed of new varieties of crops in small quantities, and to grow this in such a way that it will not only be increased rapidly but will also be kept pure.

During the past year the distribution of timothy has been the main effort. Timothy-breeding is the oldest line of work of this Department, and there have been obtained, from more than two hundred varieties, some fifteen or twenty that are considered worthy of distribution. During the last two years a large number of requests for improved timothy seed have been received. These requests have been filed in the order of their receipt, awaiting the time when they could be filled. The first distribution has now been made. Since the supply of seed was limited, this distribution was made with a great deal of care. A circular letter, together with a sheet of instructions and a coin card, was mailed to each applicant whose name was on file. Those who were willing to follow the instructions concerning the planting and care of the seed were asked to return a silver quarter in the coin card, on receipt of which a packet of the seed weighing one and one half ounces was mailed to each. It should be added that the small amount charged for these packets was utilized to defray the expense of postage and packing. There were 75 responses to this circular letter, representing 67 different localities. It is planned to keep in touch with this work by means of correspondence. It is hoped that within three years the benefits of the distribution may be apparent in a much larger way.

Organization of timothy contest.— Another important step has been made in regard to the distribution of seed and the improvement of the timothy crop. Jefferson county was chosen for this, not only because it is the center of a timothy section, but also because valuable assistance in conducting the work was offered by the Farm Bureau in that county. There were two objects in view when planning this enterprise: the first of these was the distribution of an improved variety of timothy in this good hay section; the second was the stimulation of interest in the method of timothy improvement. Personal visits were made to a large number of farmers, and to those who were willing to undertake the work a small packet of seed was given. By sowing the seed in flats, the cooperator was enabled later to transplant to the field 300 to 500 plants. These were planted in such a way as to allow of the fullest possible development. During the coming year, timothy lectures and field meetings will be held in that county, and probably a car containing a timothy exhibit will be sent through. At the end of the second season, when these plants will have reached a full growth, it is planned to hold a timothy contest in which each cooperator will enter the best ten individual plants produced in his plat. These plants will be scored by experts and liberal premiums awarded to the winners. Thus, the cooperator will not only have learned the method of the improvement of this crop, but will also have made a good beginning in selection on his own farm and will have a source of stock seed. As rapidly as possible these contests will be organized in other counties. It is believed that they will be as strong a factor in the improvement of timothy as the corn contests have been in the improvement of corn.

Wheat and oats.—A beginning has been made in the distribution of wheat and oats. Only small quantities are available, and these are being tested and increased as rapidly as possible so that a general distribution may be made. From the cooperative corn-breeding plats, some good strains are being obtained. The Department will keep a considerable amount of these on hand for distribution. In every case only a small amount of seed can be sent to any one farmer, but with careful handling this may soon be made to fulfill his needs.

Educational activities

The Department has increased materially the amount of work done along purely educational lines. Considerable material has been added to the exhibit, illustrating methods and results of plant-breeding. So far as possible, the exhibit is being put into permanent form. This exhibit was installed at three different places during the year: During Farmers' Week it was set up at the College, where a representative of the Department was continually in attendance to make explanations and answer questions. During the month of January it was installed at the Lincolndale Agricultural School, where it was inspected not only by the boys of the school but also by farmers from the surrounding community; members of the Department installed the exhibit, and a representative was there on the day of their institute, January 29, to demonstrate and explain the different features. It was also installed at the State Fair Grounds during the week of the Fair, when three representatives were in attendance.

During the past year this Department has endeavored to assist as much as possible in the work of the Extension Office. In this effort, members of the Department have given 53 lectures and have held 5 field meetings. In connection with the Extension School instruction, three days work has been given at each of five different schools.

Recommendations

The results of the extension activities for the year have been gratifying. The coming year's work should be and will be better organized. In the cooperative and demonstrative work, as well as in the seed distribution, the best results have been obtained under the personal supervision of a representative of the Department. This, however, requires much time. The work has already grown beyond the personal reach of one man; indeed, the seed distribution alone will soon demand the time of one person. It is recommended that another member be added to the Department, so that these two lines of work may be increased to the extent that their importance justifies.

Much good and interest has resulted from the exhibit work. It has proved one of the best means of arousing first interest in crop improvement by breeding. It is impossible, under the present arrangement, to install a large exhibit more than three times during the year. Therefore it is recommended that means be supplied to increase this line of work. In addition to the large exhibit, smaller ones of special crops should be prepared to send to special localities. This work could profitably consume the time of one man. It is hoped that additional funds to undertake this project may soon be available.

PUBLICATIONS

The following articles, written by members of the staff and graduate students of the Department of Plant-Breeding, either are in manuscript or have been published during the past year:

H. J. Webber. Preliminary Notes on Pepper Hybrids. Annual Report of the American Breeders' Association.

H. J. Webber. The Cornell Experiments in Breeding Timothy. American Breeders' Magazine.

H. J. Webber. The Effect of Research in Genetics on the Art of Breeding. American Breeders' Magazine.

H. J. Webber. The Production of New and Improved Varieties of Timothy. Bulletin 313, Cornell University Agricultural Experiment Station.

H. J. Webber. Conservation Ideals in the Improvement of Plants. Popular Science Monthly.

A. W. Gilbert. Suggestive Laboratory Exercises for a Course in Plant-Breeding. American Breeders' Magazine.

A. W. Gilbert and G. B. Upton. An Algebra of Mendelism and its Application to a Mixed Hybrid Population. Annual Report of the American Breeders' Association.

A. W. Gilbert. Mendelian Study of Tomatoes. Annual Report of the American Breeders' Association.

A. W. Gilbert. The Present Status of Plant-Breeding Instruction in the United States. Annual Report of the American Breeders' Association.

H. H. Love. The Relation of Certain Ear Characters to Yield in Corn. Annual Report of the American Breeders' Association.

H. H. Love. A Study of the Large and Small Grain Question. Annual Report of the American Breeders' Association.

H. H. Love. The Relation of Seed Ear Characters to Earliness in Corn. Annual Report of the American Breeders' Association.

H. H. Love. Comparison of Yield between Hybrids and Selections. American Breeders' Magazine.

H. H. Love and C. E. Leighty. Germination of Seed as Affected by Sulfuric Acid Treatment. Bulletin 312, Cornell University Agricultural Experiment Station.

C. H. Myers. Effect of Fertility upon Variation and Correlation in Wheat. Annual Report of the American Breeders' Association.

C. E. Leighty. The Correlation of Characters in Oats, with Special Reference to Breeding. Annual Report of the American Breeders' Association.

R. J. Evans. The Effect of Temperature on Stellaria media. Annual Report of the American Breeders' Association.

M. J. Dorsey. Variation Studies of the Venation Angles in Vitis. Annual Report of the American Breeders' Association.

L. D. Batchelor. Carnation Breeding. Annual Report of the American Breeders' Association.

RECOMMENDATIONS

This Department is greatly in need of proper cold-storage facilities. Much work is being done with the potato, one of the most important crops of the State. This work is greatly hindered by the lack of proper cold-storage. It seems possible that one cold-storage plant could be built, large enough for the use of all departments. Such a plant could be operated more cheaply than could separate storage rooms for each department.

The Department also needs a storage house for tools and crops, near the experimental plats on the farm. Much valuable seed was lost this summer because there was no building in which to store it until it could be threshed.

The experimental work of the Department is still handicapped by lack of space for laboratory work.

H. J. WEBBER,
Professor of Plant-Breeding.

DEPARTMENT OF PLANT PHYSIOLOGY

At the close of the period covered by this report, Professor B. M. Duggar, head of the Department, resigned to accept a position as Research Professor of Botany in the Missouri Botanical Garden at St. Louis. The Department of Plant Physiology was established by Professor Duggar. Through his tireless energy, zeal, and inspiration the Department developed to a high degree of efficiency. His reputation in botanical science gave prestige to the Department and attracted to it a large number of graduate students from different institutions. His sympathy, his counsel, and the stimulus that he gave to research, as well as his teaching, will be greatly missed.

TEACHING

During the past year the teaching division of the work has been placed on a more efficient basis. The increase in laboratory space by the acquisition of the farm mechanics laboratory made possible better laboratory teaching. For the first four weeks of the first semester, however, the students and staff were considerably handicapped by the delay in equipping the newly acquired laboratory.

The enrollment of students in the Department during the past year has shown a considerable increase over that of the previous year. This is due in part to a normal growth and also to the acquisition of increased laboratory space, making possible the accommodation of 100 students in Course 7, which, during the previous year, was limited to 50 registrations. Ten courses were given during the past year, with a total registration of 262 students. Credit hours of instruction given in the courses totaled 756. Of graduate students there were 28, of whom 7 were major students for the degree of Ph.D. and one was a major for the M.S.A. Not all these graduate students in the Department were engaged in research work, but it may be conservatively estimated that the equivalent of 160 credit hours for each semester was spent by graduate students in research work.

In the following table is presented a summary of the teaching work of the Department since the year of its organization:

Year	Number of courses given	Registrations	Credit hours of instruction	Number of graduate students
1908	3	37	134	6
1908–1909	7	110	257	19
1909–1910	8	138	326	27
1910–1911	9	173	498	27
1911–1912	10	262	766	28

Summer session

Two courses were offered in the summer session. In Course A, General Plant Physiology, there were 10 students registered. In Course B, Special Problems, 4 students were registered. In addition to the above registrations 6 of the graduate students were present for the entire summer, engaged in research work.

INVESTIGATION

Mr. Hill has completed his studies on the respiration of fruits and the effect of certain gases, aëration, and other factors on the keeping qualities. A paper will soon be available for publication.

Doctor McCool has completed his investigations on the subject of the toxicity and antagonistic action of the nutrient and other mineral bases and the effect of manganese on plants. A paper is now available for publication.

Professor Duggar has continued and practically completed his studies on the ripening of green tomatoes and especially on the factors influencing the production of the red and yellow pigments.

Professor Duggar and Mr. Prucha have continued their work on the development of the sterilized-soil method for distributing the legume-nodule-forming bacteria. During the past year, fourteen cooperative experiments with farmers in different parts of the State were conducted in order to test exactly the value of the soil cultures. Cooperative experiments are also being made with the United States Department of Agriculture. In addition, 500 cultures of the legume-nodule-producing bacteria were sent out for test to farmers in various parts of the State. The results obtained thus far have been very satisfactory. Evidence is sufficient to prove that the method here devised for the distribution of the legume bacteria is a successful one. A bulletin on this investigation will soon be available.

Mr. Prucha has been engaged during the past year in investigating various other problems connected with the subject of legume inoculations, and has paid especial attention to an investigation of the factors influencing the vitality of the nodule-producing bacteria.

During the year the writer has completed his studies on the growth of wood in the American larch and a paper will soon be in course of publication. An investigation on the regulatory production of enzymes by certain fungi has been completed by him and a paper is now ready for publication. A preliminary investigation on the growth of wood in grape, apple, and peach has been completed, and a paper will soon be available for publication. These studies are being continued in a more intensive manner.

EXTENSION

The extension work of the Department has been greater than in any of the preceding years. A large number of letters of inquiry concerning mushroom culture, legume inoculation, and various miscellaneous subjects pertaining to plant physiology have been answered. The Department has also, during the past year, again made a considerable number of identifications of weeds and other plants submitted, and has answered inquiries concerning them. This work is not normally in the province of plant physiology.

Two exhibits were made during the year. An educational exhibit, dealing primarily with legume inoculation, was made during Farmers' Week and at the same time an exhibit and demonstration of the culture of mushrooms was made. At the State Fair an exhibit, with a member of the staff in charge, was installed by this department for the first time.

As a part of the investigation work, and yet also extension work, the Department supplied 500 farmers with the nodule-producing bacteria for alfalfa, Canada field pea, soy bean, and vetch. The distribution for the year 1912–1913 will be considerably increased, as already over 500 applications have been received.

RECOMMENDATIONS

The most urgent need of the Department is more greenhouse space. The present house has a floor space of 1,150 square feet. During the first semester of last year, 125 students in course work had to make use of this greenhouse for experiments. With that number of students it was far too crowded. The crowded condition, however, is not the most serious factor. Courses in plant physiology require a large number and variety of plants. At present no space is available in which to grow such plants. There are in the Department 28 graduate students, of which number one third to one half are engaged in research work. The work of these men and the department investigations are considerably hampered because of the lack of greenhouses. In order to work efficiently the Department should have three times the present greenhouse space.

The students in plant physiology must do part of their work in the greenhouse and part in the laboratory. It would facilitate matters considerably if a greenhouse for experiment work could be attached directly to the teaching laboratory of the Department. It is not only inconvenient, it is also difficult, for the laboratory instructors to teach efficiently when they must divide their time during one period between the laboratory and a greenhouse not closely connected with it.

The Department of Plant Physiology, along with other departments, is in need of a cold-storage plant. It would seem desirable that a common plant be installed, in which various departments could be given space. Not only is such a cold-storage plant essential for investigations concerned with the cold-storage of fruits and vegetables, but it would be of much value in other investigations as well. Such a plant would be of particular value for investigations and teaching work in fermentation.

LEWIS KNUDSON,
Assistant Professor of Plant Physiology.

DEPARTMENT OF PLANT PATHOLOGY

TEACHING

During the year 1911–1912 instruction has been offered in eight courses, including those offered to regular students in Summer School. The teaching staff has consisted of six members, an increase of one over the previous year. The total number of students registered for these different courses was 206, of which 65 were winter-course students and 17 were students taking the courses offered during the summer term, leaving 124 registrations in the regular undergraduate and graduate courses. The number of graduate students in the Department again shows an increase. There were 15 students registered for a major for the degree of Ph.D., as compared with 12 in 1910–1911; 13 doctorate students with a minor in the Department, as compared with 15 in 1910–1911. There were 1 major and 1 minor for the master's degree. This increase in graduate students continues to be due largely to the increasing demands for research and demonstration work by associations of growers, and the like, which provide fellowships requiring properly trained college graduates. The increasing demand for trained men in phytopathological work is also responsible for increased registration of college graduates for this work.

The floor space devoted to the use of graduate students during the past year was less than twelve hundred square feet, an average floor space of eighty square feet per student. It is evident that under such conditions satisfactory work can hardly be expected. It should be pointed out that in nearly every case the graduate students are holders of industrial fellowships, conducting investigations of direct benefit to the growers of the State and largely supported by funds that the growers have personally provided. It would seem that the State is under some obligation to provide adequate quarters for these men.

As for the undergraduate work, the same deplorable conditions continue as for the past three years, namely, insufficient floor space to accommodate the students registering for the elementary course. In 1910–1911 forty students had to cancel their registration because of lack of room to accommodate them. This past year (1911–1912) over fifty students had to be turned away for the same reason. The practical value of some knowledge of plant diseases to students in agriculture is so evident that it would hardly seem necessary to urge adequate provision in the way of space and facilities for teaching all those who apply. Many students have sought for the past three years, with annual disappointment, admission to this course. The Department is powerless to relieve the situation until additional floor space is available.

INVESTIGATION

Satisfactory progress has been made in the various lines of experiment and investigation. Some work has been brought to a conclusion and new lines of work have been inaugurated. As in former years, the investigations have in many cases been accompanied by field experiments conducted from field laboratories, of which seventeen, located in thirteen different counties, have been maintained the past summer. Much of the experimental work has been made possible by financial cooperation with growers and commercial houses in the form of temporary industrial fellowships, seven of which have been in operation the past year. The various lines of work are mentioned in the order in which they have been begun in the Department.

Grape disease investigations.—An investigation of the dead-arm disease, which in 1909 and 1910 was conducted in cooperation with the New York Agricultural Experiment Station at its vineyard in Chautauqua county, has been continued. A second report is in preparation.

Field work on black-rot has been continued as in former years. The experimental plats were located at Bluff Point in the Keuka Lake district, but as the disease did not appear in our plats the experiments were of no value. The work has been performed by C. T. Gregory, instructor in the Department. The investigations of the downy mildew fungus have been continued and a number of interesting points established, chief among which, from the practical standpoint, is confirmation of the recently announced discovery that infection occurs exclusively through the stomata on the underside of the leaf. What effect this discovery may have on spraying operations for the control of this disease remains to be seen.

Bean disease investigation.— Professor Barrus has continued his investigations on the anthracnose disease. The work has been largely a continuation and extension of the work begun last year, on the susceptibility of the various varieties of beans and closely related plants to various strains of the anthracnose fungus. A technical article, "Variation of Varieties of Beans in Their Susceptibility to Anthracnose," has been published (Phytopathology 1:190–195. *pl. XIX.* 1911), and other articles are in course of preparation.

Nursery disease investigations.— V. B. Stewart, with the aid of four student assistants, has continued the nursery work as in former years, extending it to two additional nurseries — Brown Brothers Nursery at Rochester and the nursery of Jackson & Perkins at Lyons. Studies of fire blight, with special reference to its occurrence in nursery stock, have occupied most of the time. The outcome of investigations and of the experiments in control is now being prepared for publication.

Experimental work in the control of various foliage diseases has been continued and satisfactory progress made.

Ginseng diseases.—This work has gone forward in cooperation with the State Ginseng Growers' Association and with the Department of Cotton and Truck Disease and Sugar-Plant Investigations, Bureau of Plant Industry, United States Department of Agriculture. Bulletin 250 of the Bureau of Plant Industry, entitled "Diseases of Ginseng," has been published. The special lines of work receiving particular attention are the alternaria blight, the study of which is nearing completion, the wilt, various root rots, rust, and mildew. A technical article, "Infection Experiments with *Thielavia basicola* in Ginseng," has been prepared by Mr. Rosenbaum, special assistant in these investigations, and is now in press (Phytopathology 2:191–196. *pls.* 18 *and* 19. 1912). Other shorter articles dealing with various phases of the investigations have been published in various trade papers.

The use of sulfur and its compounds as a fungicide.— Investigation of the fungous flora of the soil, conducted by C. N. Jensen, has been brought to a close and the results have been published in Experiment Station Bulletin 315. The experiments on the use of sulfur as a fungicide for potato scab, begun by Mr. Jensen, have been continued by C. D. Sherbakoff. Another year of experimentation is required before satisfactory data from which to draw conclusions can be obtained. Mr. Sherbakoff is making an investigation of the fungous flora of the potato.

The work in control of hop mildew, which gave such satisfactory results last year, has been continued with gratifying results. Associations at Waterville and Milford, representing nearly one thousand acres of hop yards, have aided in this work. The use of various grades of sulfur has received special attention. The use of dust sprays on the foliage and fruit of apples, peaches, and plums has been continued, but, unfortunately for the investigation, there has been a dearth of diseases of these fruits again this year. At least one important point in connection with the application of a dry spray seems to have been established, namely, that a dry poison applied in dust form is thoroughly effective against the more common chewing insects attacking the apple. Professor Crosby of the Department of Entomology has assisted in taking notes on this point. Some of the dry sulfur mixtures have shown fungicidal value against the apple-scab fungus in a season of mild attack.

I. C. Jagger has continued investigations of truck-crop diseases, on the Herman Frasch Fellowship established by the Union Sulphur Company, of New York City. Experiments in the control of onion blight gave only negative results. Experiments in the control of onion smut, on the other hand, gave a remarkable increase in yield on certain of the treated plats. Attempts to control lettuce diseases have as yet been without success.

Investigation of certain aster and carnation troubles was begun July 1 by R. C. Faulwetter, on the Herman Frasch Fellowship.

Forest-tree diseases.— As was the case last year, much attention has been given to the study of the chestnut-bark disease. From observations and studies thus far made on the nature, occurrence, and spread of the disease, it seems impracticable to advise the employment of extensive control measures for woodlands of the State. Attention is being directed to utilization and to reforestation with more desirable species, as the most satisfactory way of repairing the destruction due to this devastating disease.

A twig blight of chestnut oak has been investigated, and considerable attention has been given to forest nursery troubles, including a study of white pine blister rust, Scotch pine rust, and a disease of seedling spruces. The work is being done in cooperation with the State Conservation Commission by W. H. Rankin, Forest Pathologist for the Commission and instructor in this Department.

Diseases and insect pests of fruits and fruit trees.— L. R. Hesler has continued this investigation, which is done in cooperation with the Department of Entomology. The work is supported by the Byron Fruit Growers' Association. The pathological work has been confined largely to studies of *Sphaeropsis malorum* — said to be the cause of the New York apple-tree canker — and to other canker diseases. Surgical methods and the dressing of wounds has received special attention.

Investigation of diseases of fruits and fruit trees, with special reference to the various fungicides used in the control of these diseases.— Extensive field experiments with a number of fungicides were inaugurated, but, unfortunately for the investigation, a dearth of apple diseases prevented satisfactory progress. Laboratory tests after the method devised by Doctor Wallace and reported in Bulletin 290 have progressed satisfactorily.

Gladiolus disease investigations.—The work carried forward last year by H. M. Fitzpatrick is being brought to a close. Other features of the investigation have been undertaken by L. M. Massey, assistant in the Department. Extensive experiments near Berlin, New York, have been instituted and special studies have been directed toward the control of the hard-rot disease.

Crown gall.— A number of the peach and apple trees that were set in the disease garden in order to determine the effect on them, under New York conditions, of the crown-gall disease, were injured by the severe winter and by ice. Fortunately, nearly all survived and developed a strong renewal from near the ground. It is not possible at the present time to distinguish the healthy from the galled trees.

Investigation of the fungicidal value of sulfate of iron.—The experiments on the control of raspberry anthracnose were continued as for last year, but the results were not nearly so satisfactory for any of the fungicides tried.

The work started last year on diseases of the peach and the apple was continued, but the scarcity of fungous diseases made most of the work unsatisfactory. It has been demonstrated by extensive experiments that sulfate of iron has no value for the control of the leaf-curl disease of peaches. David Gunn, a special student in Entomology, established the fact in connection with this work that iron sulfate has no value as a destroyer of San José scale. This was an important point because a fungicide having no value as a scale destroyer would be practically worthless as a dormant spray for peaches.

Investigation of peach black-canker.—This work was supported by peach-growers in the town of Newfane, Niagara county. R. A. Jehle has brought parts of the investigations to a satisfactory conclusion, but unfortunately he will not have an opportunity to continue control experiments that give promise of yielding successful results. The cause of the canker has been determined to be *Sclerotinia fructigena*, and this has been proved by repeated inoculations and isolations. Blossom blight seems to play an important rôle in the production of cankers, and the control of blossom blight has been one of the points receiving special attention. Frost cankers have been studied in this connection. The fungus *Valsa leucostoma*, frequently associated with frost cankers, has given only negative results when inoculated into healthy trees.

Peony disease investigations.—This work has been taken up in connection with the pathological work of the Society of American Florists. The botrytis blight has received some attention during the past year and a popular treatise, "A Destructive Disease of Peonies," has been published (Florists' Exchange 1912: 565–566. *figs.* 1–4).

The violet disease.—An investigation of the root rot, or black-rot, of violets has been made possible by the financial cooperation of the Rhinebeck Violet Growers Mutual Protective Association. The cause of the disease has been determined and experiments looking toward its control are now under way.

EXTENSION

The extension work of the Department has been distributed as follows: teaching, demonstration, exhibits, lectures, and correspondence.

1. *Teaching.*— During the year 1911–1912 a course in plant diseases was offered to winter-course students. This consisted of two lectures and two laboratory practices each week. As many of the students were not familiar with plant anatomy, the first four weeks of work was devoted to this subject before entering on the work in plant diseases.

Lessons on plant diseases were given in extension schools at the following places: Wyoming (Wyoming county), Alden (Erie county), Riverhead (Suffolk county), Mountainville (Orange county), Kinderhook (Columbia county), and Keuka Park (Yates county). At these schools actual laboratory work was given, with microscopes and specimens of diseased plants, and its value was evident from the interest manifested by the students.

A lesson on hop diseases was presented at the Morrisville School of Agriculture early in the year.

During Farmers' Week, lectures and practice work were offered and were largely attended.

Instruction consisting of lectures and practice work on the diseases of ginseng was offered to the visitors at the annual meeting of the New York State Ginseng Growers' Association, held at the College of Agriculture on April 26 and 27. An exhibit of ginseng diseases was provided.

2. *Demonstration.*— Demonstrations have been carried out wherever possible in connection with exhibits. At the meetings of the Fruit Growers' Association and of the Horticultural Society at Rochester during January, a demonstration of spraying, with particular reference to spraying against the wind, was given daily. On the farm trains, at the State Fair, and at the Rochester Exposition, numerous demonstrations were given to show the method of treating oats to prevent smut, and potatoes to prevent scab, and to show methods of cutting out cankers on fruit trees. Demonstration experiments were conducted in apple orchards belonging to H. L. Scribner at Plattsburg, A. G. Fletcher at Keeseville, and E. Lyman Smith at Willsboro. A spraying demonstration with a power sprayer was given at Mr. Scribner's orchard during June.

Many spraying demonstrations have been conducted in connection with the field laboratories. The fellowship men in charge have assisted the growers to a better understanding of the nature of plant diseases, and have not only offered valuable suggestions regarding their control, but have shown the growers how to put these suggestions into operation on their own farms. The extension phase of the field laboratory work has appealed greatly to the grower, and no doubt it has been influential in locating new laboratories. At Milford and Waterville men were employed by the growers themselves solely to extend the knowledge of the method of control of the hop mildew.

3. *Exhibits.*— Exhibits of the common diseases of fruit, field, and garden crops, and of the methods used in the control of diseases, were made at the annual meetings of the Western New York Horticultural Society and of the State Fruit Growers' Association, on the farm train over the Delaware & Hudson Railroad from Binghamton to Peru, on the farm train over the West Shore Railroad from Marlboro to Coxsackie, at the State Fair at Syracuse, and at the Rochester Industrial Exposition. An exhibit of the diseases of vegetables was presented at the meeting of the Vegetable Growers' Association of America, held at Rochester, and one of the diseases of ginseng at the meeting of the New York State Ginseng Growers' Association held at the College.

4. *Lectures.*— Lectures on some phase of the work on plant diseases have been given by members of the staff at farmers' institutes, at meetings of horticultural societies, before granges, improvement societies, farmers' clubs, and other agricultural organizations. The demand for lectures of this kind is increasing, and, while they are doubtless entertaining and to an extent instructive, they cannot have the educational value of demonstration meetings or of local teaching work. As far as possible we have illustrated the talks with crayon drawings and with specimens of diseased plants, endeavoring to make them more in the nature of a lesson than of a lecture. In many cases meetings have been held in the field or orchards, where practical demonstrations could be made of methods of disease control.

In all, 71 different localities, representing 32 counties of the State, have been visited by members of this Department during the year 1911–1912. More than two hundred meetings have been held, in some cases these meetings extending throughout the entire day.

5. *Correspondence.*—The correspondence of the Department is large, 3,888 letters having been written this year in addition to a considerable number of circular letters that were sent out. A large percentage of the correspondence was in reply to inquiries regarding the control of plant diseases.

RECOMMENDATIONS

The most urgent necessity for the Department continues to be floor space. With greatly increased registration in all courses and with the increasing demands for investigation laid upon us by the growers of the State, we feel that provision for large additional floor space and facilities must be provided very shortly, otherwise disintegration of the present departmental work and organization is to be expected. All the activities of the Department during the winter season, when the field laboratory men are here, have to be confined to the attic floor space of approximately twenty-five hundred square feet, divided into offices and laboratories by partitions that are for the most part only head-high. With three typewriters in constant operation, with many students doing laboratory work, photographing, making culture media, and the like, all virtually in one room, the recommendation that more room be provided for the Department would seem imperative.

Next to the need for room is the necessity for increased maintenance funds for the Department. It now takes every cent of the funds apportioned to this Department to maintain the teaching equipment and routine work and to provide equipment, inadequate even though it is, for the present field laboratories. This leaves no funds available for traveling expenses, for collecting materials for teaching, or for such investigations conducted by the staff as are not provided for by fellowship funds. Additional funds for regular maintenance should be provided to meet such expenses. The present inadequacy of maintenance funds for expenses of investigations, and the overloading of the staff with teaching and administration work, makes it quite out of the question for members of the staff to do research of any considerable extent.

The next greatest need is that of increase of staff. In the teaching work, especially in the elementary course, the staff should be at least doubled if we are to properly handle the students who desire the work. At present the excessive number of students are taught at the expense of time and energy which should be devoted to study and research by professors and instructors. The addition of another professor or assistant professor, and of two instructors, to the teaching staff is necessary. Another assistant should also be provided for the work incident to increased numbers of laboratory periods required to handle additional students.

The administration of the research work on our industrial fellowships was put into the hands of Doctor Reddick last year. Already additions to the research staff of the Department become necessary. An assistant professor and at least one instructor should be provided next year (1913–1914), to help Doctor Reddick with this work.

The extension phase of the work of this Department is at present satisfactorily provided for, although with the rapid growth of demands on the time of Professor Barrus it is evident that very shortly he will require additional staff assistance for his work.

In short, the work at present expected of the Department of Plant Pathology, aside from any extension of its activities to which it naturally looks forward, is at least double what it can properly do with its present floor space, maintenance funds, and staff.

The development of cold-storage for agricultural products has extended the work of the pathologist from the field to the storage house. The keeping qualities of diseased plants under refrigeration need careful investigation. This is particularly true in case of epidemics of disease, as, for example, late infections of apple scab or the outbreak of the potato rot and of celery blight appearing at the end of the present season. A series of small rooms which can be maintained at constant low temperature are indispensable for certain lines of investigation, and at least one large room for the storage of quantities of fruits or vegetables would prove advantageous for experimental and demonstration work. The rooms should be located preferably in connection with other storage space, in order to insure constant service and an approach to commercial conditions.

H. H. WHETZEL,
Professor of Plant Pathology.

DEPARTMENT OF SOIL TECHNOLOGY

TEACHING

During the past year the courses of instruction have been revised. Course 1, Principles of Soil Management, is now repeated in the second term. It has been possible to raise the standard of this course by admitting only regular students who have had the prerequisite training, and by providing for others a course — Elementary Soils — which is entirely different in its nature and which cannot under any circumstances be substituted for Course 1.

The number of students registered in undergraduate courses during the year was 274. Twelve graduate students took major or minor subjects in the department. Of these, four registered for major subjects for the doctor's degree, three took minor subjects for the same degree, four took major subjects for the master's degree, and one a minor for the master's degree.

The Department has been fortunate in securing the services of Dr. H. O. Buckman as Assistant Professor of Soil Technology, who will give his attention solely to the instruction of college students. The activities of the Department in the lines of college instruction, investigation, and extension each have at least one officer of professorial grade who devotes his time exclusively to the one branch of work.

INVESTIGATION

Adams fund investigations

There has been no change in the nature of the investigations conducted under the Adams Act. The four problems that were reported last year are still under investigation, but new phases of these subjects have been attacked and new methods used. The present status of each problem may be outlined as follows:

1. *Influence of soil moisture on the availability and utilization of plant nutrients in soils.*— During the past year the first phase of the work in this investigation has been completed. This consisted of a series of pot experiments in which the soil was kept at certain definite moisture contents varying from 15 to 40 per cent of the dry weight of the soil. Plants were grown in some of these vessels, and others of the vessels were allowed to remain under similar conditions except that no plants were grown in them. Treatments of soil in this way extended over a period of four years and comprised a large number of separate experiments, in

which different combinations of moisture content and fertilization were used. The results show that any increase of moisture in the soil beyond the quantity required to fill the capillary spaces is not attended by any notable change in the solubility of the plant nutrients aside from the nitrogen, the form and consequent solubility of which constituent is greatly influenced by saturation. The absorption of nutrients by plants is, on the other hand, greatly influenced by the moisture content of the soil above capillary capacity. The influence of moisture content below capillary capacity is now being studied.

2. *A study of the composition and concentration of the water-soluble material of soils under different methods of treatment.*—The main problem has been a study of the formation of nitrates and other water-soluble matter in soils as affected by the growth of certain of the higher plants. The influence of some other conditions have of necessity been studied, in order to eliminate them from the experimental results. The experiments deal with the effect of plant growth on the soil in distinction from the effect of the soil on the plant. The conclusions previously drawn, that certain plants during their early stages of growth exercise a stimulating influence on the formation of nitrates and during the later stages a depressing influence, has been confirmed. Some plants depress nitrification during almost all of their growing period. This is the case with timothy. The nature of the plant, has, moreover, been found to affect the formation of nitrates in the summer following that in which the plants were grown. These findings may have a practical bearing on the use of cover crops in orchards and in a study of crop rotations.

3. *Examination of certain properties of an unproductive soil.*—This was instigated by the occurrence of a number of poor spots in a piece of soil on the experiment field. These spots do not differ in color, composition, and texture from the more productive parts of the field, but in structure and certain other properties there are differences. The bacterial flora is also different. The correlation of the qualities that distinguish the unproductive spots — as, for example, the deflocculated condition of the particles, the increased absorption, the higher nitrate content, and the greater number of bacteria — gives a basis for studying a combination of properties, one consequent on the other, and for ascertaining whether the amelioration of one condition will lead to a correction of others. With this knowledge it may be possible to avoid more expensive soil treatments by indirect treatments that are inexpensive.

4. *The conditions under which calcium is removed from soils, and the changes that accompany its removal.*—The tendency of soils in a humid region to lose their basic constituents may be more or less controllable. The effect of different crops, cultivation, fertilizers, and the like on the

quantities of calcium and other constituents of the drainage water is being studied by means of large tanks filled with soil from which the natural drainage is collected. Analysis of this drainage shows a much greater loss of calcium from unplanted soil than from soil on which maize, oats, and timothy were grown. The difference amounted to more than two hundred pounds per acre in one year. There was a corresponding difference in the loss of nitrates from these tanks, indicating that a large removal of nitrates in the drainage water causes a large loss of lime. Of the soil constituents, calcium was removed in the largest amount, then magnesium, potassium, and sodium in the order named. The drainage water contained only a trace of phosphorus.

Other experiments and investigations

A study of soil types.— Representative samples of certain types of soil are taken from three different areas of the same type located in different parts of the State. Chemical determinations of the absolute quantities of nitrogen, carbon, potassium, sodium, calcium, magnesium, phosphorus, and carbonates are being made from these samples, also mechanical analyses and the determination of certain physical properties. It is desired to ascertain whether the chemical composition of a soil type as now classified is characteristic of that type, and fairly uniform. This, with the physical examinations, will enable us to ascertain whether there is a correlation of chemical and physical properties that distinguish the type. The study constitutes an effort to test the value of the present classification of soil types.

A comparison of the practice of fertilizing for hay crops with that of fertilizing for grain crops in a rotation of timothy and clover three years, followed by maize, oats, and wheat each one year.— It is a common practice to fertilize grain crops rather than hay. The apparent advantage in fertilizing for hay in a rotation is that by increasing the yield of hay the quantity of sod is increased, and this is in itself a fertilizer. Also, the hay crop is the most valuable of the field crops in this State if large yields are obtained. Complete fertilizers, with varying quantities of the fertilizer constituents, are being used on different plats, as are also varying quantities of farm manure. In some cases only the hay crops are being fertilized, in others only the grain crops, and in still other tests the hay crops and the wheat are both fertilized. Acid phosphate and ground phosphatic rock are being compared as a source of phosphorus. The first crop of hay was harvested during the year. One of the questions involved in the experiment is the profits from the use of large quantities of fertilizers as compared with small quantities. The law of diminishing returns entails a decreased profit at some point in an increasing quantity of fertilizer. For grain crops this point is reached with comparatively small quantities of fertilizer. This experiment indicates that for hay the profitable use of fertilizers may be extended to a considerably greater quantity.

The influence of the application of calcium in certain different chemical combinations, and of ground limestone in different degrees of pulverization, on the productiveness of certain loam and clay soils.—The experiment involves the use of burned lime and ground limestone, and of limestone ground to different degrees of fineness. The use of ground dolomitic limestone containing about the same proportions of calcium and magnesium, and of magnesium carbonate alone, is also being tried. The soil on which the experiment is being conducted contains, in its native state, a higher content of magnesium than of calcium. It furnishes, therefore, a good medium for a test of the extent to which magnesium carbonate may be used without injury. In selecting crops to be grown in the experiment, legumes and sod crops are avoided and all precaution is taken to use only crops that will not leave fertilizing residues in the soil, the influence of which on succeeding crops would be increased or decreased by the effect of the lime. Secondary effects in experiments of this kind must be avoided if primary causes are to be studied.

Top-dressing alfalfa with farm manure and with different fertilizers, also with lime.—The experiment is designed to ascertain whether alfalfa may be profitably top-dressed with the materials named, especially after it has been seeded for a number of years and is beginning to decrease in hay production, or whether it is more profitable to plow it up and reseed. The alfalfa now under experimentation was seeded in 1905. A very profitable result has been obtained from the use of 100 pounds of superphosphate per acre.

Continuous cropping of land with maize and hay; the latter crop being designed to maintain the supply of organic matter in the soil, but omitting entirely a return of mineral matter to compensate for that annually removed by the crop.— Numerous experiments have demonstrated that continuous cropping of soil without manures decreases crop yields, but in such experiments the supply of organic matter has not been maintained. In this experiment it is being attempted to keep up the supply of organic matter by growing a hay crop four years and a maize crop one year in every five. The hay is removed each year, but the sod is plowed under when the land is prepared for maize. The yields of both hay and maize, but especially those of maize, are being taken as a measure of the productiveness of the soil.

The nitrogen balance in soils growing different legumes, and in soils growing timothy, when the hay crops are removed.— Our experiments have shown that legumes increase the rate of nitrate production in soils, as compared with grasses. It is well known that legumes use nitrate nitrogen in large quantities. It is therefore a question how much of the large quantities of atmospheric nitrogen fixed by legumes is kept in the soil when the crops are removed, how the different species of legumes differ in this respect, and how they compare with timothy.

The use of fertilizers on a nurse crop with which timothy or timothy and clover are sown.— On certain of the experiment plats on which fertilizers were used on the nurse crop when sown to timothy and clover, the yields of hay were less the first year of cutting than on the plats on which no fertilizer was used for the nurse crop. The point to be determined is whether the profit from the increased growth of the nurse crop will offset the delayed growth of the hay crop. The experiment is designed to furnish information on that subject, and also on the profitableness of applying fertilizers in separate parts, the nitrate nitrogen being reserved for use directly after removing the nurse crop, at which time it is of greatest service to the young growth of grass.

The fertilizer needs and lime requirements of certain muck soils.—The fertilizer and lime requirements of muck soils differ with different deposits. Local tests are being made at certain points and it is expected that information of general application will ultimately be gained.

Local fertilizer tests.—Tests of different kinds and quantities of fertilizers applied to a rotation of crops, with and without the application of lime, are being conducted for the purpose of ascertaining the fertilizer needs of the particular soil under experiment. When a sufficient number of these are in operation, they will furnish information on the possibility of determining the fertilizer needs of any soil type by conducting experiments on a representative soil of that type.

EXTENSION

The term "extension," as commonly used, does not correctly indicate the scope of work of the extension section of this Department. It is better defined by the term "extra-college work," in the sense that it embraces all those activities of the department beyond the university, or college, plant.

The work divides into two groups, the first and primary of which is of an investigative and experimental nature; the second is instructional in nature, and the one contributes to the other and makes it more specific and useful. The first group includes: (1) Soil survey, (2) chemical survey, (3) drainage survey, and (4) field plat studies. The second group includes: (1) Correspondence, (2) extension school work, (3) special lectures, (4) demonstrations, and (5) special soil problems.

The soil survey aims to classify, locate, and describe the important soils of the State, and thus to make available to all persons the facts of their character, around which most other agricultural data are grouped and on which basis important and essential lines of further investigations should be founded. This work continues in cooperation with the United States Department of Agriculture, M. E. Carr and G. A. Crabb representing the Bureau of Soils and Tracy M. Morrison and Earl T. Maxon representing this Department in the field work. This was in progress from October 1 to November 20, 1911, in Jefferson county, covering 420 square miles and finishing the 1,252 square miles in the county; from May 20 to September 30 in Orange county, covering 650 of its 849 square miles; and from June 25 to September 30 in Oneida county, covering 360 of its 1,180 square miles — a total area for the year of 1,430 square miles. The expenditure of the Department in this connection was approximately $1,700. The total area represented by these three counties is 3,281 square miles. The total territory in the State covered by soil surveys is 11,150 square miles, in nineteen areas.

The reports and maps covering the surveys in Monroe and Ontario counties were published in May by the United States Department of Agriculture.

Attention is again called to the fact that the State has never published any of the reports on soil surveys in the preparation of which it has had a part, and the congressional edition is so small that this College is practically without copies of the reports for distribution. It is not necessary to duplicate the mechanical work of publication, which is expensive, as the reports, either in print or in plate, can be purchased from the Federal printer and the maps can be purchased from the lithographer, provided orders are placed at the time when they are being put through the press. These may then be inclosed in appropriate covers for the College of Agriculture.

Drainage.—The interest in the practice of farm drainage continues to grow. The desirability of affording more assistance to farmers in the layout of farm drainage systems has been emphasized in past reports. During the present year a special effort has been made to give some assistance of this sort by way of demonstrations of methods of farm drainage. Following a statement in the Announcer of the College of Agriculture, that a limited amount of drainage survey work could be done, applications for such aid were received, and continue to come, in larger numbers than can be handled. Eighteen farm surveys were made and the systems of drains outlined by representatives of this department. Besides these, seventeen applications were refused because of lack of facilities. The surveys made cover 2,000 acres. Approximately one fourth of this was absolutely swamp land. The remainder consists of ordinary farm land too wet for profitable crop production.

In addition, an application was received for aid on a swamp drainage project, involving three or four square miles of muck and otherwise wet land. As this was a larger undertaking than our men have been accustomed to handle, the assistance of the Federal Office of Drainage Investigations was invited and the work was covered in cooperation with that office.

The result of drainage surveys is summarized in a blue-print map showing the form of the land, the arrangement, size, and grade of the drains, and a report calling attention to special features to be observed in the construction of the system, which is furnished to the person assisted so that the plan may be carried out at his convenience.

In all this drainage work, men have been employed at a per diem salary and expenses, the latter being paid by the parties assisted. To carry this amount of drainage work has been a very severe tax on our resources, and in view of the limited funds at our disposal no projects of this sort will be accepted during the coming year except as the applicant may be willing to pay both expenses and per diem salary. This arrangement will, of course, be conditioned on the availability of suitable men to make such a survey. Under these conditions the delays in the proper completion of the survey work are likely to be long.

The educational value of such a survey to the community would be greatly increased by a meeting in the field with the expert, of the inhabitants of the region, using the particular project under consideration as an illustration.

Correspondence with the people of the State continues to grow. The number of regular letters sent out during the year was 3,150, an increase of 53 per cent over the preceding year. In addition, 2,750 circular letters were sent out, making a total of 5,900 letters, or an increase of 58 per cent.

Lectures.— Nineteen lectures were given outside the College, aside from those in extension schools.

Soil problems.— Many farms were visited in connection with local general and special problems in soil improvement.

Exhibits were made at four county and state fairs and at the meeting of the Vegetable Growers' Association of America.

Extension schools.— Instruction in soils was given in three extension schools held during the winter, aggregating thirteen days.

PUBLICATIONS

T. Lyttleton Lyon and James A. Bizzell. Experiments with Reinoculation of Steamed Soils. Proceedings of the Eighth International Congress of Applied Chemistry, 1912, pp. 159–178.

T. Lyttleton Lyon. Some Experiments to Estimate Errors in Field Plat Tests. Proceedings of the American Society of Agronomy, Vol. 3 (1911), pp. 89–114.

Oscar D. von Engeln. Some Factors Influencing the Percentages of Mineral Plant Foods Contained in Soils. American Journal of Science, Vol. 32 (1911), pp. 350–358.

George Bouyoucos. Transpiration of Wheat Seedlings as Affected by Soils, by Solutions of Different Densities and by Various Chemical Compounds. Proceedings of the American Society of Agronomy, Vol. 3 (1911), pp. 130–190.

J. Oscar Morgan. The Effect of Soil Moisture and Temperature on the Availability of Plant Nutrients in the Soil. Proceedings of the American Society of Agronomy, Vol. 3 (1911), pp. 191–249.

H. J. Conn. Bacteria of Frozen Soil, II. Centralblatt für Bakteriologie, etc., II Abt., Bd. 32 (1912), pp. 70–97.

H. O. Buckman. The Chemical and Physical Processes Involved in the Formation of Residual Clay. Transactions of the American Ceramic Society, Vol. 13, pp. 337–384.

Elmer O. Fippin. The Soil: Its Use and Abuse. Cornell Reading-Course Lesson for the Farm, Vol. I, No. 2, Soil Series No. 1, October, 1911, pp. 1–16.

Elmer O. Fippin. The Chemical Analysis of Soil. Circular No. 12, Cornell University Agricultural Experiment Station, January, 1912, pp. 4.

Elmer O. Fippin. The Practical Classification of Soil. Proceedings of the American Society of Agronomy, Vol. 3 (1911), pp. 76–79. Science, N. S., Vol. XXXV, No. 905, pp. 677–686.

Elmer O. Fippin. The Agriculture of New York. American Journal of Geography, March, 1912.

Elmer O. Fippin. Onions on Muck Soil. The Vegetable Grower, Chicago, April, 1912.

RECOMMENDATIONS

Laboratory space.— Practically the same congestion in the laboratories exists at present that was felt when our last report was made. There is no laboratory for advanced students, and graduate students must work either in the elementary laboratory or in the experiment station laboratory. This class of students is only partially provided with desk room for the material, books, notes, and the like, which are a necessary adjunct to the work.

Soil improvement plats.—A series of soil improvement plats should be established in different parts of the more important soil types, to be continued for a series of years. This would serve three purposes: (1) To determine the needs of each soil type; (2) to serve as a demonstration in each community; (3) to supply a source of experiment data and a basis for research.

Farm drainage.—The first step in the improvement of much of the arable soil in this State is the securing of adequate drainage. This is now coming to be recognized by a large number of land owners and there is a constantly increasing call for aid from the College. The giving of such aid generally necessitates a survey of the land and the preparation of maps for a system of drains. A member of the college faculty who could give his entire time to soil drainage would be able to prepare students capable of doing much of this work, and at the same time to give neighborhood demonstrations that would increase interest in the subject. The expense of the work and demonstration should be borne by the parties who receive the benefit.

The writer recommends the appointment of an assistant professor of soil drainage, to supply what is now the most urgent need of this Department in its relation to the student body and to the agriculture of the State.

Soil survey.—This College should have one permanently employed officer on each of the areas being surveyed by cooperative arrangement between the College and the United States Bureau of Soils. To do this would necessitate an increase in the appropriation for the survey work.

The writer recommends that provision be made for the issue by the State of 5,000 soil survey reports for each area, preferably by purchase of reports from the Federal printer and maps from our lithographer, to be published as regular bulletins of the Experiment Station of this College. If the arrangement suggested does not conform to the rules governing state publications, it is recommended that the material as prepared for the Federal reports be presented to the state printer for publication in our regular series of bulletins.

Glasshouses.— It is desirable that the glasshouses used by this Department should be of a kind especially adapted to the needs of the work, instead of being of the type used for horticultural work. It would also be an economy in time and in energy to have the two houses side by side, instead of separated as at present.

T. LYTTLETON LYON.
Professor of Soil Technology.

DEPARTMENT OF HORTICULTURE

The year has been one of unusual misfortune to the Department in the prolonged illness and recent death of Professor John Craig. The Department also lost three assistants in the middle of the year, who left for more lucrative positions in the commercial field. Notwithstanding these unfortunate interruptions in the work, all the courses were given with the exception of two during the last semester, and no lines of experimental work have been discontinued.

TEACHING

Ten students pursued graduate work in the Department during the past year. These were distributed as follows: Major for doctor's degree, 2; minor for doctor's degree, 3; major for master's degree, 5. Four of the candidates passed their examinations in June and two in September.

The undergraduate work in floriculture and vegetable-gardening progressed as satisfactorily as facilities permitted, but the courses in horticulture were hampered for the reasons stated above. The classes in nuciculture and evolution of plants were discontinued during the spring term, although there was a good registration of students. It was unfortunate that the first-named subject could not be given, since the course had been offered for only two or three years and was attracting a larger number of students each year. The popularity of this course was the inevitable result of the method of its presentation and of the increasing interest in nut-growing in the Northern States.

The increased interest in floriculture and vegetable-gardening has made it necessary to add certain subjects. Next year it is proposed to offer the following new courses:

Course 16. Garden Flowers. This three-hours course is designed to acquaint the students with garden plants and to give practical knowledge of the propagation and culture of the annuals, herbaceous perennials, bulbs, and shrubs used for cut flowers or in ornamental planting.

Course 24. Floral Design. This one-hour course is a study of the principles of floral art. It includes practice in the arrangement of flowers in designs and bouquets, baskets, table decorations, interior decoration, and the like.

Course 29. Home Vegetable-Gardening. This two-hours course is a study of vegetables and their production for home use. The planning and management of the garden, special crop requirements, factors influencing quality, and control of pests will be considered. The laboratory work consists of actual practice in the garden. The starting of early plants in hotbeds and frames, and intercropping and succession cropping for securing the largest yields from small areas, will be studied. Each student will assume charge of his own plants and will carry them through to the end of the term.

As soon as a suitable greenhouse can be built for maintaining a collection of conservatory plants, the following additional course will be given: Conservatory Plants. A two-hours course consisting of a study of the culture and uses of tropical and subtropical plants grown in conservatories, including palms, ferns, begonias, orchids, and the like.

Winter-courses.— Last year the Winter-Course in Horticulture was modified so as to give the student the option of one of the following lines of work: fruit-growing, vegetable-gardening, or floriculture. This allowed him to specialize in the branch in which he was particularly interested, and the remainder of his course was made up of closely related subjects. The results of this division of the course were very satisfactory. There were 12 students taking vegetable-gardening and 10 taking floriculture, out of a total registration of 67 students.

Summer School.—A three-weeks course in vegetable-gardening and a similar course in floriculture were offered in the Summer School. The registration was 40 in vegetable-gardening and 38 in floriculture. The response, therefore, was such as to warrant a full course in each subject in the next Summer School. We realize the great opportunity in teaching these subjects in the summer, when there is such a wealth of plant material. It has been found that there are two classes of students — those wishing instruction in commercial work, and those who desire to teach or who are interested only in amateur flower- or vegetable-growing. We hope that we shall soon be able to provide courses for each of these classes of students.

INVESTIGATION

Peony studies.—The investigation of the peony, along the lines agreed on by the Department of Horticulture and the American Peony Society, has been concluded. The identical plants used in preparing the descriptions printed in the three bulletins issued have been removed and planted in the permanent peony garden, where they will remain as a living herbarium available for study and observation by all persons interested in peony culture. It is hoped that additional varieties may be added as they are introduced, so that the collection will always be complete. Although the study of varieties has been completed, there is need that the results be brought together in a final publication, which should give complete information on the culture and varieties of peonies.

Sweet pea studies.—These have been continued in cooperation with the American Sweet Pea Society. A large number of varieties of winter-flowering and garden types have been grown. As the work progresses we are gradually overcoming the difficulties met with at its inception, and we hope to conduct some further cultural experiments in addition to the nomenclature studies. The results of the study of the winter-flowering sweet peas have appeared as Experiment Station Bulletin 319. A report of the work in progress with the garden varieties has been published as Experiment Station Bulletin 320, and there are sufficient data for another publication which it is hoped may be issued soon.

The gladiolus.—This in another piece of cooperative work, in connection with the American Gladiolus Society. The study is similar in character to that undertaken with peonies and sweet peas. A large number of varieties have been grown and careful notes made. As soon as it is thought that the work has progressed far enough to warrant it, a publication will be issued giving the results. In addition to the field studies, some experiments have been made in forcing several varieties of gladioli, including a study of the effects of etherization. These studies will be continued for another year.

As opportunities offer, data are being accumulated on the plant-food requirements of roses, carnations, and chrysanthemums. In the field work, collections of phloxes, irises, and hardy chrysanthemums are being grown for study. During the past year a large number of new varieties of annual flowers have been tested. It is hoped that with our increased experimental areas, this latter phase of our work will attract the attention of the introducers of new varieties of plants, so that the Department may become a clearing-house for new varieties of ornamental flowers.

Vegetable experiments on muck lands.—These experiments have been conducted this year on muck-land areas in the western, north central, and eastern sections of the State. A study is being made in order to ascertain the best methods of supplying nitrogen to the leading muck-land vegetable crops, and also to determine the value of rotation. On the Canastota area a large variety test was made with lettuce and onions, in order to ascertain the adaptability of different varieties to muck-land conditions. A considerable amount of data have been gathered for publication, relating to the growing of lettuce, celery, and onions on muck soil. The experiments will be continued until conclusive results are obtained.

Vegetable-accounting.— This investigation is being continued and extended. This year sixty account books were placed in the hands of growers who agreed to undertake the work. The supply of books has not been equal to the number of requests for them. The accounts of expenditures and income will, when tabulated, give the most reliable data on the production of the leading vegetable crops of the State.

Fertilizers.—An experiment with fertilizers with hubbard squash, for determining the relative value of commercial fertilizers and manures applied broadcast and in hills of squash, was begun this year and has produced marked results. It is planned to continue it for one or two seasons.

Tomato experiments.— Studies have been made, in the field and under glass, to ascertain the factors or conditions causing cracking of tomato fruits. Examination has been made of the pollen of tomatoes grown with different fertilizer applications, with respect to the setting of fruit. These studies have been made by G. M. Ignatiev, a graduate student in the Department.

Oriental pears.—A study of the commercial status of the oriental pear in the United States — an investigation by H. R. Cox under the direction of Professor Craig — has been prepared for publication.

EXTENSION

The Department has given such assistance as it could by organizing local vegetable-growers' associations. When possible, a representative of the Department has met, for the discussion of vegetable problems, such organizations as exist. Paul Work, instructor in vegetable-gardening, is secretary of the New York State Vegetable Growers' Association. A very successful and well-attended meeting of this association was held at the College during Farmers' Week. The association was again instrumental in bringing together, at the New York State Fair, a large and attractive exhibit illustrating various methods of packing vegetables.

The florists of New York State met with the Department during Farmers' Week and organized the New York State Federation of Floral Clubs. All the important floricultural organizations of the State joined the federation, and delegates were sent to the annual meeting at the State Fair.

The writer attended the meetings of the American Sweet Pea Society at Boston and the American Gladiolus Society at Chicago, and reported on the work in cooperation with special floricultural societies and on the trial grounds.

The annual meeting of the American Peony Society, held at the College of Agriculture in June, was well attended. The Department placed on exhibition all the varieties of peonies growing on the trial grounds, and large numbers of persons visited the fields during the blooming season. The cool weather was especially favorable to the plant, and the size of the plantation and extensive collection of varieties all combined to prepare for the visitors the most magnificent peony show ever held in America.

The Department prepared an exhibit and sent representatives to the meeting of the Vegetable Growers' Association of America, at Rochester. The exhibit made at the State Fair was very much improved in character, and it was thought that great good was accomplished.

One of the most important meetings of the year was that of the Northern Nut Growers' Association, held at the College of Agriculture last December. This was largely attended. The Morris collection of edible nuts of the world, collected through the efforts of Dr. R. T. Morris, of New York City, and donated by him to the Department, added much to the interest of the meeting. Forty persons in various parts of the country sent in specimens of nuts to compete for the prizes offered by Doctor Morris. Great interest in nuts has been aroused and letters are constantly coming in asking for information regarding nuts.

Among the many pieces of work in the nature of extension might be mentioned the assistance given in preparing the revised premium lists for flower exhibits at the State Fair.

RECOMMENDATIONS

The most urgent need of the Department is more greenhouse space. The present glass area is insufficient to provide enough work for our students in greenhouse practice. This course, revived at the beginning of the year, has been very popular with the students, who appear to be exceedingly anxious to get actual practice in handling and growing plants. This work is fundamental to the courses in vegetable-gardening and floriculture, and so long as a considerable number of our students come to us without practical experience it is desirable that we exert ourselves to provide such facilities as we can.

Also, we have not been able during the past year to afford the necessary space for investigative work by undergraduate and graduate students. Some of this was of a scientific character, and the results of all the problems under experiment were beneficial to the students.

The regular instruction in floriculture and vegetable-gardening has been hampered by insufficient space for growing all the leading crops. The instruction, so far as it relates to many of the standard, or leading, crops, has of necessity been mainly theoretical except such knowledge as the class obtains from brief trips to greenhouse establishments. We have not the houses to force roses, violets, cucumbers, or tomatoes in winter. None of the crops grown have been on a scale sufficient to provide the proper amount of laboratory practice for students. During the year all regular experimental work under glass has been discontinued because the houses were required for instruction. This means that we are not in a position to assist the florists and vegetable-growers of New York State in solving their greenhouse problems. In order to undertake work for these horticulturists, there is needed a thoroughly modern commercial range of greenhouses.

An ideal arrangement would be to erect a moderate-sized building adjacent to the greenhouse range. This building should provide classrooms, laboratories, offices, herbarium, and photographic laboratories. A great gain in effectiveness would result if all the horticultural staff were located in the midst of their work. If not already too·late, a site should be selected near the College to provide for these structures.

The Department is in need of cold-storage facilities. Last summer the Department was brought face to face with the problem of handling a large number of cut flowers for the peony exhibition. An attempt was made to cool down a room in the basement of the Dairy Building by the use of ice, but the results were only partially successful. Also, the space was very limited. In order to insure the exhibit of the true varieties from the trial grounds, the society was compelled to give up its own competitive exhibition. We need the storage, not only for cut flowers and experiments on them, but also for vegetables, bulbs, roots, and the like for class work.

A. C. BEAL,
Assistant Professor of Floriculture.

DEPARTMENT OF POMOLOGY

TEACHING

The instruction in pomology is planned to cover the different phases of fruit-growing. A course in Elementary Pomology consisting of two lectures and one laboratory period, given in the first term, covers the fundamental principles. Following the elementary course, the practical work is given in a course consisting of three lectures each week during the second term.

Additional work in pomology is taken up by other courses. A course in Advanced Practical Pomology provides training in the varieties of the different fruits, in judging work, and in the preparation of plans for planting and managing orchards. Courses in Small Fruits, Spraying of Fruit Trees, and Systematic Pomology, each taking up its particular field, prepare the student for practical and experimental work.

The number of students registered in pomological courses during the year 1911–1912 was as follows:

	First semester	Second semester
1 Elementary Pomology	257	....
2 Practical Pomology	....	203
4 Small Fruits	....	83
6 Spraying of Fruit Trees	....	104
8 Advanced Practical Pomology	79	....
10 Systematic Pomology	....	8
13 Research	19	13
14 Seminary	....	13
Graduates taking major	5	2
Graduates taking minor	5	1
Total	365	427

The total registration for the entire year was 792.

INVESTIGATION

Because of the large registration and the lack of assistants in the Department, very little research was undertaken during the year 1911–1912.

Considerable attention has been given to the care and planting of new orchards. About fifty acres of land on the university farm have been set aside for pomological work. The planting is now nearly completed.

In connection with the planting of these orchards, the first two experiments mentioned below were continued during the summer. These are long-time experiments, extending over several years.

Variety tests.—A collection of varieties of each fruit is being made. The purpose of this collection is two-fold: first, to study commercial varieties as regards hardiness, productivity, variability, and quality; second, to study new varieties as regards adaptability to conditions in New York.

The value of selected scions.— In the case of several varieties of apples, scions have been selected from bearing trees which are known to be productive and the fruit of which is excellent as to type. Scions are also chosen from the nursery row and from trees the fruit of which is inferior in type. The products will be compared.

Irrigation in New York as it affects the peach.— In cooperation with the Department of Soil Technology and with W. E. Barger, of Lockport, an experiment was started last spring to determine the results of irrigating a peach orchard. Mr. Barger furnished the peach orchard and the money for the plant, which when installed had a capacity of 400 gallons per minute. Water has been applied at regular intervals during the summer and the results have been computed. The experiment will be continued for three years.

EXTENSION

During the college year members of the staff have spoken at a large number of meetings in various parts of the State. Early in May the Department was represented on a farm train, which was run from Marlboro to Coxsackie over the West Shore Division of the New York Central Railroad. The extension work of the Department may be expressed as follows:

Lectures	31
Farm inspections	21
Demonstrations	12

Each year a fruit exhibit is held at the College, both for the education of the students in the Department and for the benefit of fruit-growers and consumers in the vicinity of Ithaca.

The Department is prepared to send experts to inspect fruit farms and advise the owners whenever time permits. The only charge made for such an inspection is to cover the actual expenses of the inspector. Several farms in New York State have been visited during the year and the owners advised in regard to the care of them.

RECOMMENDATIONS

There is a pressing need for a man to take up research in pomology. This work of the Department has not received the attention that it deserves. The Department will be much more efficient and helpful to growers in New York when this work can be undertaken.

There is also great need for satisfactory storage space and for sufficient offices, laboratories, and classrooms. The only storage space available is a small room in the basement of the Dairy Building. Not only is this too small, but it is impossible to reduce the temperature sufficiently to preserve fruit. A mechanical storage, with one large room (1,000 barrels capacity) and several smaller rooms for experimental work, is needed. It will be necessary in the immediate future to provide a packing house and barn on the pomology grounds, and in connection with this a residence for the foreman of the grounds.

The Department needs more office room. At least four additional offices are necessary at this time to accommodate the members of the Department. The need of a laboratory for graduate students is pressing. At the present time there are several graduate students in the Department, but there is no place where they can work without interruption.

C. S. WILSON,
Professor of Pomology.

DEPARTMENT OF FORESTRY

The first step in the organization of a department of forestry was taken on December 17, 1910, when the Board of Trustees appointed a professor of forestry. This professor was on duty at the College of Agriculture from January 26 to February 24, 1911, and on June 15, 1911, he began regular work at the College. During the year 1911–1912 the staff was increased by the appointment of an assistant professor, who began work on January 1.

EQUIPMENT

In the winter of 1911–1912 the Legislature appropriated $100,000 for a forestry building at the College of Agriculture. During the year the plans for the building have been completed.

Eight woodlots and a farm of thirty-eight acres on the university farms have been placed in charge of this Department. The woodlots include stands of white pine, hemlock, and hardwoods, and present a wide variety of silvicultural conditions. Part of the area is open land, suitable for experimental plantations.

The Department has begun the collection of an equipment of forestry instruments and of materials for illustrating class work. The forestry library has been materially increased. This being a new Department, the purchase of much office equipment has also been necessary.

AIMS OF THE DEPARTMENT

Forestry uses certain classes of soil for raising crops; an agricultural college without a forestry department is therefore incomplete. The Department of Forestry at Cornell University aims to take its proper place among the other departments of the College of Agriculture in helping to develop the argricultural resources of the State.

The agricultural resources with which this Department is concerned are lands that cannot be used more profitably for cultivated crops or for pasture; that is, forest lands. Whether the tract of forest land is a farm woodlot of only one acre and is to be used for raising a very minor crop among other more important crops, or whether the tract is a hundred thousand acres and is to be managed permanently by a lumber company as the only business in which it engages, is immaterial. It is the function of this Department to help the owners of both these tracts, just as it is the function of the Department of Pomology to help, on the one hand, the general farmer who wishes to plant a dozen fruit trees to supply his home table, and on the other hand the orchardist whose sole business is the handling of several hundred acres of fruit.

The Department aims, therefore, to train some students in the care of the woodlot as a secondary business on the farm (farm forestry), and to train other students in the care of a large forest as a business in itself (professional forestry); furthermore, it aims to give direct help to the small woodlot owner and to the large timberland owner.

Another aim of the Department is to conduct investigations that will help in solving the forestry problems of the State. The lands that have been placed in charge of this Department will be developed as a forest experiment station. In addition, field studies in other parts of the State will be undertaken when opportunity permits.

To summarize, the aims of the Department are:

1. Instruction — to a relatively large number of general students and to a small number of professional students.
2. Investigation — a forest experiment station and field studies.
3. Extension work — direct help to both large and small owners of forest property.

TEACHING

During the year covered by this report, instruction in the care of woodlots was given by means of four courses. Detailed plans were also completed for the professional course in forestry, but students were not admitted to this course until September, 1912. The professional forestry course requires five years, leading to the degree of Bachelor of Science at the end of the fourth year and to the degree of Master in Forestry at the end of the fifth year.

The following courses of instruction were given in 1911–1912:

Course	Term	Number of hours credit	Number of students registered
Silviculture	1	3	35
Silviculture	2	3	24
Farm Forestry	2	2	113
Farm Forestry	Winter-Course	....	24
			196

The above registration was composed entirely of undergraduate students, excepting one candidate for the master's degree who had a minor in forestry.

INVESTIGATION

Twenty-five experimental forest plantations were made near Ithaca on land belonging to the University. This involved the planting of over thirty thousand trees. Permanent silvicultural sample plots were established in woodlands near Windham, Greene county, and near Elmira, Chemung county.

EXTENSION

The extension work was as follows:

1. Eleven lectures on forestry were given outside of Ithaca. Three lectures were given at Ithaca during Farmers' Week.

2. The first bulletin was published in the Farm Forestry Series of Cornell Reading-Course Lessons for the Farm.

3. A circular letter was sent to all former students of the College who are now living in New York State, offering to make an examination of their woodlands or of land to be planted with forest trees, the only expense to the owner for the examination and for a report being the necessary traveling expenses of the Department's representative. The same offer was made to all land owners of the State through the Announcer of the College of Agriculture, through the agricultural papers, and through general press notices.

4. Thirteen examinations of forest lands were made in accordance with the above offer.

5. One cooperative agreement was made with a private woodland owner, for the establishment of a demonstration woodlot.

6. Exclusive of circular letters the departmental correspondence numbered about two thousand letters, many of which were in the nature of extension work.

7. The Department had an exhibit at the State Fair.

RECOMMENDATION

The greatest need of the Department is a demonstration and experimental forest tract of two thousand to five thousand acres.

WALTER MULFORD,
Professor of Forestry.

DEPARTMENT OF ENTOMOLOGY

TEACHING

The courses of lectures and of laboratory work offered in the College Announcement, 36 in number, were given as announced and in nearly every case they were well attended.

There was a marked increase in the number of students taking work in the Department. The total number of undergraduates was about six hundred, and of graduates sixteen.

The scope of the instruction given was enlarged by the transference of the work in nature-study to this Department, and by the establishment of a course in Aquiculture under the direction of Assistant Professor Embody.

INVESTIGATION

The results of several pieces of investigation by members of the staff of the Department and by advanced students have been published during the past year. A list of the more important of these publications is given below. Some of this investigation has been referred to in previous reports as being in progress, but in the accompanying list only published works are included. Many short communications that have appeared in scientific journals and in leaflets are omitted from this list.

J. H. Comstock. The Spider Book. A manual for the study of spiders and their near relatives, scorpions, pseudoscorpions, whip scorpions, harvestmen, and other members of the class Arachnida found in America north of Mexico, with analytical keys for their classification and popular accounts of their habits. 735 pages, 770 illustrations. Doubleday, Page & Co., Garden City, New York.

J. H. Comstock. The Evolution of the Webs of Spiders. Annals of The Entomological Society of America, Vol. 5, pp. 1–10.

James G. Needham. Notes on a few Nymphs of Agrioniae (Order Odonata) of the Hagen Collection. Entomological News, Vol. 22, pp. 342–345, October, 1911. 1 plate.

James G. Needham. Notes on Some Nymphs of Gomphinae (Order Odonata) of the Hagen Collection. Entomological News, Vol. 22, pp. 392–396, November, 1911. 1 plate.

James G. Needham. General Biology. Fourth (revised) edition, February, 1912. 542 pages, 283 figures. Comstock Publishing Company, Ithaca, New York.

James G. Needham. Fish Culture for Farmers. Canadian Farmers' Magazine, June, 1912.

James G. Needham. Strict Priority in Nomenclature. Entomological News, Vol. 23, June, 1912, pp. 271–272.

William A. Riley. Notes on Animal Parasites and Parasitism. Lecture outlines of a course in Parasitology, with special reference to forms of economic importance. 54 pages.

William A. Riley. Notes on the Relation of Insects to Disease. Lecture outlines of a course given by the Department. 51 pages.

William A. Riley. Concurrent Infection by Five Species of Intestinal Worms, Including *Schistosoma mansoni*. Science, October 18, 1912, Vol. 36, pp. 531–532.

William A. Riley. The Relation of Insects to Disease. The Cornell Countryman, October, 1911, pp. 12–15.

Glenn W. Herrick. Some Scale Insects of Mississippi, with Notes on Certain Species from Texas. Mississippi Agricultural Experiment Station, Technical Bulletin No. 2, 78 pages, 33 plates.

Glenn W. Herrick. Notes on Insects of Economic Importance. Outlines of lectures in Economic Entomology. 122 pages.

Glenn W. Herrick and H. H. Whetzel. The Control of Insect Pests and Plant Diseases. (Reprint.) Cornell University Agricultural Experiment Station Bulletin 283.

Glenn W. Herrick. The Fruit-tree Leaf-roller, with Notes on Allied Forms. Cornell University Agricultural Experiment Station Bulletin 311.

Glenn W. Herrick. The Larch Case-bearer. Cornell University Agricultural Experiment Station Bulletin 322.

Cyrus R. Crosby. The Plum Leaf-miner. Cornell University Agricultural Experiment Station Bulletin 308.

Robert Matheson and C. R. Crosby. Aquatic Hymenoptera in America. Annals of The Entomological Society of America, Vol. 5, pp. 65–71.

George C. Embody. A Preliminary Study of the Distribution, Food, and Reproductive Capacity of Some Fresh-water Amphipods. 33 pages, 1 plate, 5 text figures. International Revue der gesamten Hydrobiologie und Hydrographie, 1912.

A. B. Comstock. Handbook of Nature-Study for Teachers and Parents. This book is planned to meet the needs of untrained teachers. The facts that the teacher should know regarding each topic treated are given in the "Teachers Story," which is followed by a lesson outlining the observations to be made by the children. There are 234 lessons, 150 of which bear directly on Agriculture. 950 pages, more than one thousand illustrations. Comstock Publishing Company, Ithaca, New York.

Anna Clegg Stryke. The Life-cycle of the Malarial Parasite. Entomological News, Vol. 23, pp. 221–223, 1 plate.

Anna Haven Morgan. Homologies in the Wing-veins of Mayflies. Annals of The Entomological Society of America, Vol. 5, pp. 89–106, 5 plates.

Charles P. Alexander. A Peculiar New Crane-fly from Porto Rico (*Tipulidae, Diptera*). Psyche, Vol. 19, pp. 63–66, 1 plate.

Charles P. Alexander and M. D. Leonard. Venational Variation in *Cladura* (*Tipulidae, Diptera*). Journal of the New York Entomological Society, Vol. 20, pp. 36–39, 1 plate.

P. E. Smith. Specific Characters Used in the Genus *Pseudococcus*. Annals of The Entomological Society of America, Vol. 4, pp. 309–327.

Henry E. Ewing. The Origin and Significance of Parasitism in the Acarina. Transactions of The Academy of Science of St. Louis, Vol. 21, pp. 1–70, 7 plates.

Several pieces of investigation have been completed and the results are ready for publication. Among these are the following:

A revision of the genus *Megastigmus*, being a continuation of the work reported in Bulletin 265, " On Certain Seed-infesting Chalcis-flies," by C. R. Crosby.

A study of the apple maggot, by J. F. Illingworth.

A study of a new pest of cherries, by J. F. Illingworth.

The following are some of the subjects that are being investigated:

Certain external parasites of domestic fowls, with methods of control, by Glenn W. Herrick.

The control of two elm-tree pests, by Glenn W. Herrick.

The life history and control of certain clover pests, by Glenn W. Herrick.

The life history and control of the codling moth in western New York, by R. W. Braucher.

A study of the onion thrips, by J. C. Faure.

Jointworms infesting grains and grasses, by C. R. Crosby.

The tarnished plant-bug, by C. R. Crosby.

EXTENSION

The extension work of the Department has been largely in the field of economic entomology. This has included attendance at fairs with exhibits of insects of economic importance, lectures before agricultural societies, visits to localities where outbreaks of insect pests have occurred, an extensive correspondence with farmers and fruit-growers, and cooperative experiments in the control of insect pests.

The cooperative experiments in progress are the following:

Control of the codling moth at Batavia, under the direction of Professor Herrick.

Control of orchard pests in the Champlain Valley, at Plattsburg, Peru, Keeseville, and Willsboro, under the direction of Professor Crosby.

Control of the grape leaf-hopper in the Lake Keuka grape region, under the direction of Professor Crosby.

Control of cranberry pests at Riverhead, Long Island, under the direction of Professor Crosby.

Control of the plum lecanium at Rochester, under the direction of Professor Crosby.

RECOMMENDATIONS

The time has come when it is impossible to carry on the work of the Department in the best manner in the rooms available. The writer therefore recommends that steps be taken to secure the erection of the proposed building for this Department at the earliest possible moment. A brief statement of present conditions will show the urgency of this recommendation:

The Department has no lecture room sufficiently large to hold the larger classes, and in one case, that of General Biology, it has been necessary to go beyond the limits of this College to find a place in which to hold the lectures. But as it seems probable that the completion of the Auditorium will afford relief in this particular, it need not be dwelt upon. It is to the insufficiency of laboratory space that the writer wishes to call attention.

A large part of the work in the Department requires laboratory space. The following table will show the number of laboratory assignments for the present term:

General Biology	640
The Farm	480
General Entomology	155
Parasitology	66
Insect Morphology	40
Systematic Entomology	26
Nature-Study	22
Graduate Students	20
	1,449

The minimum time of a laboratory assignment is two and one half hours per week; in the case of advanced students it is usually much more. At the present time the graduate students are scattered about. Some are working in the Insectary, far removed from the library and the collections, some are in the roof garden, and some are in corners of badly congested laboratories where it is impossible to have the quiet necessary for satisfactory research.

For one class — that in The Farm, which numbers 480 students — the Department has been unable to find any laboratory quarters. At the time the course was announced, arrangements were made by which the headhouse of the conservatory was to be used for work in stormy weather; but later this was found impracticable: It is therefore necessary to conduct that work entirely in the field, whatever the condition of the weather. This may not be a serious matter for robust young men; but it does not seem wise to require young women, of which there are many in the class, to run the risks of such exposure.

In order to provide for the laboratory work in General Biology and for that in Parasitology, it has been necessary to have sections in the forenoon as well as in the afternoon. This has made it very difficult for students to schedule their work. The forenoons should be left free for lectures and for other class work, much of which, in the case of freshmen and sophomores, is taken in the College of Arts and Sciences.

A second recommendation that the writer begs leave to make is that more adequate provision be made for conducting the extension work of this Department. The control of insect pests is one of the more important of the subjects in which there is a demand for extension work. The members of the staff of the Department have shown their ability and willingness to carry on researches in the field of economic entomology. But it is not wise to ask a professor to leave his classes in order to go away from Ithaca for extension work. Our first duty is to those who have come to Ithaca for instruction. The only suggestion which the writer can make for the solution of this problem is that a man should be appointed who can devote his time to extension work. Such a man should be well fitted by training and experience for this work, and should be a good popular teacher.

J. H. COMSTOCK,
Professor of Entomology.

DEPARTMENT OF DAIRY INDUSTRY

TEACHING

The total number of students receiving instruction in the Department during the year was 764. The numbers registered in the various courses are given below:

Regular courses.—The same courses as were outlined last year have been continued and three new ones have been added, as follows:

Course 16. Milk Composition and Tests (for special students).
Course 18. Butter-making (for special students).
Course 19. Advanced Cheddar-cheese-making.

The number of students enrolled in the regular courses during the year was 547. Their distribution among the different courses is as follows:

Course		Number of students
1	Milk Composition and Tests (given both semesters)	157
2	Butter-making	33
3	Cheese-making	22
4	Elementary Bacteriology	28
6	Market-milk Inspection	69
7	Advanced Testing	9
8	Dairy Bacteriology	20
9	Advanced Butter-making	9
10	Fancy-cheese-making	5
11	Dairy Equipment and Business Methods	9
12	Seminar (given both semesters)	12
13	Research (given both semesters)	5
14	General Agricultural Bacteriology	43
15	Bacteriology for the Home	30
16	Milk Composition and Tests (for special students, given both semesters)	45
18	Butter-making (for special students)	16
19	Advanced Cheddar-cheese-making	4
Graduate Students		31
	Total enrollment of students for year	547

This is an increase of 19 per cent over the enrollment for last year.

Winter-course instruction.—The number of students enrolled for the twelve-weeks Winter-Course in Dairy Industry was 93. These students devoted their entire time to work given by this Department, with the exception of a three-hours course in Feeds and Feeding given by the Department of Animal Husbandry and a one-hour course in Veterinary Hygiene given by the College of Veterinary Science. The work consists of two lectures from eight to ten o'clock each morning, followed by practical work in the various laboratories until 4.30 or 5 p. m.

In addition to the regular winter-course students, 68 persons in the Winter-Course in General Agriculture elected a three-hours course in Farm Dairying given by this Department, making a total of 161 winter-course students receiving instruction in the Department of Dairy Industry.

Creamery managers' course.—This course, which was tried for the first time a year ago, was repeated this year with 13 men taking the work. Only men who are actual managers of creamery plants are admitted to this course and the work given is of an advanced character.

Summer session.— Forty-three students who were registered in the Summer School in Agriculture elected work in dairy industry.

Changes in department staff.— On December 1, H. L. Ayres was transferred from the position of Superintendent of Dairy Manufactures to that of Extension Instructor. He has spent practically all of his time, outside of the Winter-Course, in extension work in different parts of the State, working chiefly in connection with dairy plants operated by our former winter-course students.

T. J. McInerney was appointed Assistant in Market Milk and Testing, and H. M. Pickerill as Assistant in Butter-making, both appointments beginning October 1, 1911.

On January 1, 1912, H. W. Middaugh was appointed Superintendent of Milk Supply to take up a part of the work formerly done by Mr. Ayres.

During the year two members of the staff have resigned. These were Lois W. Wing, whose resignation took effect July 1, and L. B. Cook, who resigned September 30.

INVESTIGATION

The investigative work conducted by the Department this year has been along the following lines:

1. *Cow-testing-association work.*—This is a continuation of the work outlined in previous reports. This work is giving very satisfactory results and has proved of value to farmers in increasing the profit of their herds, and also to the Dairy Department because of the increased milk supply resulting from the work.

2. *Market-milk inspection.*—This work is done in cooperation with the City Board of Health for the purpose of controlling and improving the

city milk supply of Ithaca. All the farms from which Ithaca receives its milk supply have been visited twice during the year — once during the summer and once during the winter — and scored on the basis of the sanitary condition existing on each farm. This work has enabled the dairymen to make inexpensive improvements that have not been a hardship to themselves, and has given to the city consumer milk of high sanitary quality.

3. *Methods of testing cream for butter-fat.*— Much research work has been done on the testing of whole milk for butter-fat, but comparatively little on the testing of cream. Immense quantities of cream are bought and sold on the basis of percentage of butter-fat contained, and an accurate basis of computation is therefore necessary. The Department has been doing considerable work in order to determine the most accurate methods for this purpose.

4. *Studies on the incorporation of moisture and salt in butter.*—This is of special importance at the present time in view of the general agitation relative to the legal limits for butter. It is hoped that this work will show reliable methods for making butter containing uniform amounts of salt and moisture.

5. *Studies in the variation of cream from the hand separator.*— One of the difficulties encountered when the hand separator is used on the farm lies in the fact that the cream is not uniform from day to day. Various factors control this question and the purpose of this investigation is to determine what methods are necessary in order to get satisfactory results from the use of hand separators, both from the standpoint of the dairy farmer and from that of the creamery.

6. *Methods of cooling milk.*— One of the most important factors in the proper handling of milk is the maintenance of low temperatures. Since this requires either an abundance of cold water or the use of ice, the proper cooling of milk is a matter of some expense to the farmer. The purpose of this investigation is to determine what methods are most efficient and can be used with least expense to the milk-producer. The proper cooling of all milk received at a creamery or cheese factory would make it possible to manufacture a higher grade of products, which would be sold for better prices and give better returns to the farmer.

7. *Metallic flavor in butter.*—This is a trouble which causes serious losses to the butter industry of this State and which has puzzled even the best butter-makers. The discovery of the cause and of methods for preventing its occurrence will be of great value to the butter industry.

8. *Factors determining the yield of cheddar cheese.*—This is an important question from the standpoint of the cheese industry of the State.

Many factories are not getting the yield of cheese that they should from the amount of milk handled, and a careful study of the factors determining the yield should result in valuable information. In connection with this work a careful study is being made of the amount and distribution of moisture in cheese.

EXTENSION

Some of the work described under the head of "Investigation" might also be included in "Extension." This is especially true of the cow-testing-association work and the milk-inspection work. Since the close of the Winter-Course, Mr. Ayres has devoted his entire time to inspection work in different parts of the State. His efforts have been directed primarily toward assisting former winter-course students who are now located in dairy plants in this State. It has been the policy of the Department to give sufficient time at each plant to enable the man in charge to overcome his difficulty. Usually this has not required more than one day, but in a few cases several days have been spent at a single plant. The Department believes that it is better to do thorough work in a limited number of plants than to merely visit a larger number without making sure that the operator has been able to overcome his difficulty. A few dairy farms have also been visited and assistance has been given in dairy work. During the season 128 dairy plants have been visited. It is believed that this work is very important and that the results will be of great value to the dairy industry of the State.

Educational scoring of dairy products.—This work has been continued during the year on practically the same lines as before. Butter- and cheese-makers and milk-producers in any part of New York State can send samples to the Department once each month to be scored for quality. Detailed reports are returned to the sender, with suggestions for improvement of quality when these are needed.

Publications.— Only one publication has been issued by this Department during the past year. This is Cornell Reading-Course Lesson for the Farm, Vol. I, No. 16, Dairying Series No. 1 —"Practical Dairy Problems." This bulletin is intended primarily for men who desire to know the best methods for marketing their dairy products, from either the standpoint of the producer or that of the factory.

Correspondence.—The correspondence of the Department during the past year has increased materially over that of former years. Many inquiries are received from dairymen both in this and in other States, and considerable time is required for answering these inquiries promptly and furnishing the information desired.

Institutes and exhibits.— Members of the Department have taken part in farmers' institutes, local farmers' meetings, and institute schools.

Exhibits and men have also been sent to a number of county fairs and to the State Fair.

NEEDS OF THE DEPARTMENT

The increase in students taking dairy work has very seriously crowded the Dairy Building. More space for laboratories is greatly needed. Instruction should be given in several lines of dairy work for which there is now no space nor equipment. This includes especially instruction in milk-condensing, the manufacturing of milk sugar and casein, and additional work in market milk for which there are now very inadequate facilities.

A small refrigerating plant is needed for both experimental and instruction work. This might be a small plant, which could be used for some particular part of the dairy work and would furnish the necessary facilities for instruction and investigation.

W. A. STOCKING, JR.,
Professor of Dairy Industry.

DEPARTMENT OF ANIMAL HUSBANDRY

TEACHING

The instruction work of the Department is shown in the following table, giving numbers of courses and the number of students in each course:

Course	Number of students	
	First semester	Second semester
1	190	64
2	......	59
3	85	102
5	78	....
6	......	....
10	32	20
12	17	2
14	3	....
20	......	35
Total	405	282

Summer School A	17
Summer School B	17
Group I Agriculture	24
Total	58

Winter-Course 3	276
Winter-Course 4	78
Total	354

In addition there were 3 graduate students taking major work in this Department, who received the degree of Master of Science in June, 1912.

INVESTIGATION

Investigations in this Department have continued along the same general lines as heretofore. The most notable new line of investigation undertaken is an attempt to develop the early breeding habit of ewes. It is planned to continue this for at least ten years, and a longer time may be necessary in order to obtain definite results. For this purpose the entire early-lamb flock of the College is being used.

At the present time investigations are being actively conducted on ten different subjects, all of which give promise of affording useful material for publication although many will have to be continued for several years. Brief outlines of these investigations follow:

A study in dairy heredity, by Professor H. H. Wing. This is intended to show the effect of selection and use of improved sires in the development of a family of cows. The work has accrued in the development of the well-known Glista family. The investigation was begun in 1887 and will be continued indefinitely.

The cost of production of winter lambs, by Professor Wing. This is a continuation of the records of the early-lamb flock, a report of the progress of which was published in Experiment Station Bulletin 309 as a continuation of work started in 1903.

Demonstration of the effect of breed and individuality on the production of pork, by Professor Wing. The object is to show the relation of breed and individuality in pork production. Weanling barrow pigs are bought in the spring of each year and fed for pork production, records of food consumption being kept. They are sold for pork or slaughtered in the early fall. The study was begun in 1910 and will continue for at least five years.

Development of the early breeding habit of ewes, by Professor Wing. This is in order to ascertain whether the selection of first-dropped lambs will be followed by early breeding in those selected. From the early-lamb flock the first ten vigorous ewe lambs are selected each year to replenish the flock, and records are kept of their progeny in successive generations. The work was begun in November, 1911, and will continue for at least ten years.

Oats compared with corn and oats for the work horse, by Professor M. W. Harper. The object is to ascertain the comparative value of oats, and corn and oats, as a grain ration for the hard-working horse. The study will include observations on both the condition and the spirit of the horse. The investigation was begun in November, 1910, and will probably be concluded in the spring of 1913.

The cost of raising colts from birth to three years of age, by Professor Harper. The purpose is to ascertain the cost of producing horses in New York, to include both heavy and light horses; also, to ascertain the effect of different foods on the development and usefulness of the horse. The study was begun in May, 1909, and will be continued for ten years.

A study by Professor Harper to compare a ration consisting of grain and of succulent food such as silage and carrots, with a ration of grain and clover hay, in fattening young draft horses for the market.

Improving farm horses, by Professor Harper. This study is intended to show the effect of selection in breeding, and of improved care and management, on the future development of the horse. It was begun in November, 1910, and will be continued for at least ten years.

The cost of raising heifers from birth to maturity, by Professor E. S. Savage. There are parts of New York State in which it may be better to purchase grade heifers outright than to raise them, depending on the cost of raising. This project aims to throw some light on the problem. At the same time, data in this work will be available on the best methods of raising calves when skimmed milk is procurable and when it is not. The investigation was begun in September, 1910, and will continue until September, 1915.

The cost of milk production, by Professor Savage. There are comparatively few sets of records kept in detail on farms. The purpose of this investigation is twofold: to determine the cost of milk and butterfat, and to determine a method of keeping stable records which will be accurate yet not too cumbersome for a farmer to keep up. The study was begun in September, 1910, and will be completed in September, 1915.

EXTENSION

The extension work of the Department has been considerable during the past year. An assistant professor, H. A. Hopper, was employed temporarily for three months during the winter and spent the most of his time at extension schools. The other members of the staff have made lectures and attended meetings as opportunity allowed.

A large part of the extension work of the Department consists in the supervision of the records of pure-bred cows for advanced-registry registration. During the year ended May 1, 1912, the records of 1,992 pure-bred Holstein cows, belonging to 326 different owners, were supervised continuously for various periods of seven to ninety days. In addition, monthly inspections of two and one half days each were made for all the owners requesting them, for cattle entered on yearly records. At the present time the Department is supervising the records of 104 Ayrshire cows belonging to 9 different owners, 56 Guernsey cows belonging to 8 different owners, 231 Jersey cows belonging to 15 different owners, 31 Holstein cows belonging to 7 different owners, and 1 Brown Swiss cow; a total of 423 cows belonging to 40 different owners. This required the services of one hundred and nineteen inspectors, about seventy-five of whom were constantly employed for four to five months.

The development of the Department has been greatly augmented during the past year by the provision for the new buildings for administration and for stock-judging. When these buildings are completed, it will be necessary to largely increase the teaching staff. Considerable additional funds will also be necessary for maintenance.

H. H. WING,
Professor of Animal Husbandry.

DEPARTMENT OF POULTRY HUSBANDRY

The work of the Department has increased each year in proportion to the rapid growth of the College, as is clearly shown in this report. The activities fall naturally into four main divisions — teaching, investigation, extension, and administration.

TEACHING

The courses in poultry husbandry have been reorganized so as to include five one-term, two-hours, specialized courses — Poultry Farm Management, The Breeds and Judging, Marketing, Poultry for the Household, and Poultry-house Design and Construction — and a general elementary course in Farm Poultry.

The following table shows the number of university hours taught in poultry husbandry for each year from 1903 to 1912, inclusive:

	1903–1904	1904–1905	1905–1906	1906–1907	1907–1908	1908–1909	1909–1910	1910–1911	1911–1912
Regular and special courses.	74	339	158	474	527	589	329	620	915
Winter Poultry Course.....	.....	225	540	690	690	780	825	810	825
Winter-Course, elective....	54	60	80	64	66	62	66	108	120
Summer School...........	.....	.....	.....	.....	.....	.....	.....	.....	33
Total................	128	624	778	1,228	1,283	1,431	1,220	1,538	1,893

The number of students registered in the Department for the year 1911–1912 was as follows:

Regular students..................................	113
Special students..................................	70
Winter-Course in Poultry Husbandry.......................	56
Students electing poultry husbandry from other winter-courses..	60
Summer School three weeks............................	29
Summer School six weeks.............................	21
Total	349

The increase in amount of instruction given by the Department in nine years is marked. In 1903 the total registration was 28 regular and special students electing a two-hours course and some practice courses, and 27 students in the Winter-Course in General Agriculture electing a two-hours course, making a total university credit of 128 hours. In 1911–1912 the number of students taking courses in the Department was 349, carrying a credit of 1,893 university hours.

Our anticipated occupation, early in the college year, of the new Poultry Building will relieve the seriously congested condition of office, lecture, and laboratory room that has long existed, and will enable the Department to furnish exceptional facilities for instruction.

INVESTIGATION

One hundred and fourteen projects have been investigated since the Department was established. Twelve investigations have been conducted during the past year, as follows:

1. Breeding to produce a general-purpose fowl that will lay white eggs. Fourth year, one flock, 17 individuals.
2. To determine the correlation of physical characters and egg-production. Second year, 558 females.
3. Methods of feeding fowls to improve the Cornell ration for egg-production. Four flocks, first year, 42 individuals.
4. Types of rations as affecting egg-production. First year, four flocks, 64 individuals.
5. Winter range versus close confinement as affecting egg-production, fertility and hatching power of eggs, and vigor of stock. Second year, two flocks, 74 individuals.
6. Breeding for fecundity. Fifth year, three flocks, 233 individuals.
7. Comparison of large grass range versus small bare yards as affecting egg-production, and fertility and hatching power of eggs. Third year, six flocks, 192 individuals.
8. Natural versus artificial incubation as affecting vitality, fertility, and hatching power of eggs. Third year, four flocks, 67 individuals.
9. Breeding to improve the market quality of eggs. First year, nine flocks, 65 individuals.
10. The effect of removal of the thyroid gland on the health and productiveness of fowls. (In cooperation with the Department of Physiology.) First year, two flocks, 16 individuals.
11. The feeding of high-fat and high-protein rations and their effect on egg-production, fertility and hatching power of eggs, and vigor of stock. (In cooperation with the Department of Agricultural Chemistry.) First year, two flocks, 30 individuals.
12. A comparison of nine methods of keeping eggs for hatching. Third year. The number of eggs used for the year 1911–1912 was 1,650.

The stock used exclusively in investigations for the year 1911–1912 was: Females, 734; males, 66; total, 800.

The same number of projects, requiring more fowls, is planned for the next fiscal year.

One experiment station bulletin — No. 318, "Constitutional Vigor in Poultry" — has been prepared. Several bulletins are being written.

Approximately one half of the buildings, equipment, and mature stock is used exclusively for investigation.

Special scientific apparatus is being purchased to equip the new Poultry Building. This will enable the Department to investigate several important problems that it has heretofore been unable to undertake.

EXTENSION

The Department aims to be helpful to the largest possible number of persons in the State who can be reached with the facilities at hand.

Extension work away from the College.—The principal extension activities for the past three years, outside the College, may be grouped as follows:

	1909-1910	1910-1911	1911-1912
Farm visits to assist in selecting breeding stock, grading eggs, laying out plans for poultry farms, and the like	17	62	180
Speaking engagements in connection with poultry shows, granges, young men's Christian associations, farmers' institutes, extension schools, farm trains, and the like	109	79	92
Educational exhibits staged in connection with poultry shows, agricultural fairs, young men's Christian associations, farm trains, extension schools, and the like	18	23	34
Total	144	164	306

Correspondence.—The following table shows the number of letters written by the Department each year, from October 1, 1908, to October 1, 1912:

	1908-1909	1909-1910	1910-1911	1911-1912
Letters	7,088	7,470	7,364	8,456
Form letters	......	......	2,393	2,141
Total	7,088	7,470	9,757	10,597

The present office force cannot keep up the work without employing a large amount of extra help by the hour. It will be necessary to employ an extra stenographer and helper for the coming year.

Educational exhibits.—The three educational exhibits belonging to the Department are being remodeled and improved each year. They are proving to be important educational agencies, in cooperation with poultry associations and other organizations.

Poultry survey.—Twenty farms have been carefully studied and data obtained as to their business organization, using our poultry farm management blanks. We have records of replies to our question or survey blanks, from 237 persons who are especially interested in poultry husbandry.

Organization of poultrymen.—The Department is endeavoring to assist existing poultry associations and to organize others, with the object of having an active organization in every county and in many towns of the State.

Market survey.—A special study is being made of the poultry- and egg-market conditions in this State, from the standpoint of the producer, the dealer, and the consumer.

Cooperative marketing association.—A cooperative egg- and poultry-marketing enterprise, to assist the producers in the vicinity of Ithaca, is being worked out.

Breed-testing project.— Owing to a lack of facilities permitting continuance of the work under conditions that would meet the needs of the farmer, coupled with the imperative demand for houses to provide instruction in feeding practice, this important work was reluctantly suspended for the year.

Demonstration and laboratory instruction.— Experience in giving demonstrations and conducting laboratory exercises in killing, picking, packing, and judging poultry, candling and grading eggs, the study of the egg, and the like, in the tent at the New York State Fair, on the farm trains, and in the extension schools, clearly demonstrates the growing demand for this form of extension teaching. The lectures alone do not fully meet modern requirements. The people are no longer willing only to hear about things; they are anxious also to see and do these things themselves. We must more and more, in our extension work, substitute "showing" and "opportunity for doing" for mere "telling."

ADMINISTRATION

The value of the land, buildings, stock, and equipment on July 1, 1912, and for each of the four years preceding, is shown in the following table

It will be seen that there has been each year a constant and gradual increase of the total inventoried value, as follows:

	1908	1909	1910*	1911*	1912*
Land	$1,000	$1,000	$3,500	$3,500	$3,500
Buildings	5,876	6,248	6,416	6,438	7,225
Stock	2,696	2,034	3,400	3,098	4,264
Equipment	3,569	4,676	6,496	6,975	7,471
Total	$13,141	$13,958	$19,812	$20,011	$22,460

*Includes fifty-acre farm on which annual rental is paid.

Land.—The land now available or occupied by the Department is in three widely separated places, as follows: First, about five acres in the old poultry plant near the buildings of the College of Agriculture. This is now used for investigation and instruction. Second, about two acres (now partially graded) around the new Poultry Building. Third, eighty-one acres, about one mile distant from the College and north of Forest Home, where all the stock is reared and farm crops are grown. This amount and location of land makes administration difficult and expensive.

The estimated value of the land available for the use of the Poultry Department (not including land adjacent to the new Poultry Building) is $3,500.

The land adjacent to the new Poultry Building should be used exclusively for teaching. The poultry farm should be used for four purposes: First, to keep all the stock used in investigative work, which will then be separated completely from the teaching enterprise; second, for our breed-testing project, which should be increased to one hundred or more flocks; third, to demonstrate a proper poultry-farm cropping system; fourth, to rear all our stock under normal farm conditions. When properly equipped the farm will be very largely, if not entirely, self-supporting (aside from general administration and foreman supervision), without lessening its efficiency as a teaching and investigating enterprise.

A larger area of land could be used to good advantage. In the near future, more land will be imperative if we are to practice the type of poultry farming that we teach, and if we are to handle the enterprise economically. Fifty acres is too small an amount of land to make the most desirable poultry-farm unit. We should have not less than eighty to one hundred acres in order to handle our teams and tools to the best advantage and to grow a proper rotation of crops and provide suitable pasturage for our stock. We need this extra amount of land now.

Water supply for the farm.—We are greatly handicapped in the economical administration of the poultry farm, owing to the lack of a regular water supply. This has made it necessary to haul by team all the water from the creek in the valley, about one half mile distant, for rearing three thousand or more chickens each year. A suitable water supply should be provided. This may be obtained from the gorge by a ram, or from the farm by a driven well and windmill or engine power. It would be a profit-paying investment from the standpoint of saving labor, as well as furnishing a superior quality and regular supply of water.

Other needs of the farm.—The farm should have a boundary fence. The woodlot should be fenced for a turkey and game-bird preserve, for investigation and instruction. Much of the farm would be greatly improved by tile-draining. A ten-acre apple orchard should be planted in the rearing park, to provide shade and to carry out our system of cropping for a New York State poultry farm.

The marked increase in the crop-producing power of the land, which is apparent each year, justifies the belief that a substantial net profit (not counting general administration and foreman supervision) may be expected when the size of the farm is increased and it is properly equipped with water supply, tools, buildings, and the like, for efficient administration.

Buildings.—The weakest factor in our system of departmental administration is the lack of sufficient and suitable auxiliary buildings. This deficiency will be greatly increased when the Department occupies the new Poultry Building. The new building will provide lecture and laboratory facilities for two hundred and fifty or more students at one time, and many more may be accommodated when all the teaching periods are used. Facilities for teaching the practice courses in feeding, brooding, judging, and the like, as they should be taught, are limited at the present time to less than one hundred students. By curtailing the breed-testing and investigative work this year and reducing the amount of practice that each student may receive, we are planning to teach 115 students in the Winter-Course in Poultry Husbandry. This number, which is more than twice as many students as we have taught before in the Winter-Course, is about one half the capacity of the lecture and laboratory facilities. Because of this lack of auxiliary buildings, the Department may be unable to accept a number of students who will apply for instruction this winter. The writer therefore urges, as the most imperative need of the Department, the erection this year of auxiliary buildings, essentially as recommended in the ten-year plan.

Removal of present plant.—The fact that the new Poultry Building will now become the center of operations for the Department, that it contains all the lecture and recitation rooms, laboratories, locker rooms, offices, mechanics room, marketing room, and so on, and that it is located about one eighth of a mile distant from the old plant — where the practice courses must be taught to not less than two hundred students this year and where all the experimental flocks are kept—makes it exceedingly difficult to administer, and objectionable alike from the standpoint of the student and from that of the staff. The writer urges that the present plant buildings, which can be used to advantage, be removed to the farm or to the land adjacent to the new Poultry Building.

Residence on the poultry farm.—The fact that there is no residence on the poultry farm makes it difficult, if not impracticable, to use the farm during the winter owing to the distance of the buildings from suitable rooming and boarding facilities. During the summer season two employees occupy a portable bungalow. A separate residence, or house accommodations in connection with other buildings, for a married man and for single men should be provided. This would cost $2,000 or more.

Stock.—The amount of stock at the close of the fiscal year 1911–1912, and for four years preceding, is shown in the table below. The amount of stock is limited by our lack of suitable auxiliary buildings, and is not sufficient to meet the demands for teaching and investigation. The inventoried value of the stock on September 30, 1912, is $4,264.

	1908	1909	1910	1911	1912
Old....................	829	739	1,045	1,495	1,561
Young................	3,298	3,683	2,803	3,031	3,502
Total..............	4,127	4,422	3,848	4,526	5,063

The remarkable egg yields of four White Leghorn hens, bred and reared by the Department, is worthy of a place in this report. So far as we know, their records have not been equaled elsewhere. While the records of these fowls are remarkable when only their first year's production is considered, the heavy yield maintained or increased in the second or third years is the great achievement that registers the "high-water mark" in the egg-producing power of the domestic fowl. The records are as follows:

Date first egg was laid	Hen No.	Name	Number of eggs laid first year	Number of eggs laid second year	Number of eggs laid third year	Total
Dec. 4, 1908	1463	Cornell Surprise..	180	186	196	562
Nov. 24, 1909	9363	Madam Cornell..	245	131	158	534
Dec. 6, 1909	3211	Lady Cornell....	257	200	186	643
Dec. 10, 1909	3418	Cornell Supreme..	242	198	213	653

1463. Third year ended December 4, 1911.
9363. Third year ends November 24, 1912.
3211. Third year ends December 6, 1912.
3418. Third year ends December 10, 1912.

Equipment.—The $15,000 appropriation for equipping the new Poultry Building is being expended with the object in view of providing the facilities most immediately necessary. Considerable important scientific apparatus and some furniture will still be required before the building is fully equipped to meet our requirements. The total value of the equipment of the Department on July 1 was $7,471, not including the special $15,000 appropriation mentioned above.

Maintenance.—The occupation of the new Poultry Building calls for larger maintenance appropriations because of the increased expense for maintenance of the Department in three widely separated places — the old poultry plant, the farm, and the new Poultry Building. We need now a larger instructing, investigating, and extension staff. We shall need to have appointed, in the near future, an additional assistant professor, an instructor, and several assistants.

Our aim is fourfold: It is of equal importance that we find new problems first-hand, by keeping in close touch with poultrymen through our extension work; that we study these problems in our investigations to discover new truths, which may lead to the adoption of better methods; that we carry, to the large number of persons who cannot attend College, the largest possible measure of useful instruction and inspiration; that we teach the most efficient principles and practices to the students who come to the College.

JAMES E. RICE,
Professor of Poultry Husbandry.

DEPARTMENT OF FARM MECHANICS

TEACHING

With the completion of the Farm Mechanics Building, a floor space of 40 by 80 feet is made available for the teaching work and a space of about 12 by 40 feet for office and tool-room purposes. While these quarters are entirely inadequate for the thorough teaching of farm mechanics and farm engineering, still they are so far superior to the facilities previously enjoyed by the Department that much better teaching has been done for nearly one fifth more regular students than ever before and with less proportionate effort. This change is due partly to increased space, partly to special conveniences, and partly to freedom from the restraint imposed by being housed with other departments.

The number of students who received instruction in the courses offered by this Department is given in the following list, from which it will be noted that a new course in Dairy Mechanics was added, in response to a request from the Department of Dairy Industry, and a brief course was given in the summer session:

Regular courses	Number taught	Number marked
3 Farm Mechanics. Fall	87	79
3 Farm Mechanics. Spring	143	125
4 Dairy Mechanics. Spring	16	15
19 Research. Fall	1	1
20 Farm Engineering. Fall	41	39
20 Farm Engineering. Spring	52	40
28 Research. Spring	11	7
Winter-course		
Farm Mechanics (General Agriculture 7)	114	105
Summer school		
Farm Mechanics (Agriculture 10)	39	38
Total	504	449

INVESTIGATION

During the past year special attention has been given by the writer to the problem of developing simple apparatus for the disposal of sewage from (a) small households, (b) boarding-houses with variable flow, and

(c) creameries. The details of the type of septic tank developed during the preceding year have been modified so as to increase the efficiency of the tank and at the same time simplify its construction. Special modifications of the general design have been made to suit each of the types of cases given above, and through cooperation with private parties several typical installations have been constructed which will serve as experimental plants. A serious problem in connection with sewage disposal is that of distributing the effluent of the septic tank uniformly over the purifying bed without the use of expensive apparatus and also without loss of head, which is in many cases absolutely unobtainable. This is particularly true of the small domestic plants, thousands of which must be installed in the next few years if our farmers are to develop the conveniences of their homes as they should. In order to meet this need the writer has designed and perfected the Cornell sewage switch and sewage divider, two small fittings which from the drawings provided may be easily constructed at negligible expense by any farmer reasonably handy with tools and familiar with mixing concrete. These fittings are now being used in a number of cases in order that they may be fully tested before their use is extensively recommended.

A small steam boiler for use by fruit-growers in boiling lime-sulfur was tested as to capacity, data as to amount of steam used for this purpose were obtained, and a report was submitted to the manufacturer.

At the request of the Department of Plant Pathology the details of a type of collapsible spray tower suggested by them were perfected and two of the towers were built and used for demonstrating purposes. Drawings and specifications were prepared for distribution.

The investigations in farm engineering, under the immediate charge of B. B. Robb, were conducted either independently by this Department or in cordial cooperation with other departments conducting investigations in which special engineering work of any kind was required. These problems were as follows:

1. The design, installation, and operation of an irrigation plant at Brockport, New York, for the purpose of determining the best method of applying water for irrigation to land of this type in New York State. Conducted in cooperation with the departments of Pomology and Soil Technology.

2. The study and solution of especially difficult engineering problems in connection with proposed or existing drainage systems in various parts of the State.

3. The design, construction, and use, in cooperation with the Department of Soil Technology, of an instrument for automatically recording the discharge of a drainage system, the instrument developed having been named a "drainometer."

4. At the suggestion of the Department of Soil Technology Mr. Robb was requested by the Fiscal Supervisor of the State Board of Charities to conduct some special engineering investigations which that board had in mind, for the purpose of determining whether or not drain tile could be made from materials available on the state farm at Sonyea, New York, and if so what machinery equipment would be required for commercial manufacture and what would be the probable cost of the same. Four samples of clay and shale were studied and mixtures of a number of different proportions were tested at several different temperatures and periods of burning. The existing commercial brick plant was carefully studied, modern methods were fully investigated, and a complete report was submitted.

5. Investigations were begun to determine the durability of cement tiles for drainage and the possibilities of their economical home manufacture by farmers.

EXTENSION

Owing to the very limited departmental funds and lack of properly trained persons available for the purpose, very little extension work on the subject of mechanical matters was undertaken. Two exhibitions of the Cornell sprayograph in use in testing spray nozzles were made at fruit-growers' meetings, and apparatus was installed at those meetings for use by the Department of Plant Pathology in demonstrating the proper method of spraying in the wind. At the State Fair at Syracuse an exhibit of small domestic sewage-disposal plants was given. In addition, inquiries by correspondence and from visitors were answered. These included many questions on sewage disposal, the answers to many of which necessitated special drawings whose preparation drew heavily on the time of the writer.

In farm engineering considerable extension work was done by assisting farmers in the engineering difficulties connected with their drainage problems. Sixteen farms were visited, seven in cooperation with the Department of Soil Technology, five in cooperation with the New York State Department of Agriculture, and four independently by this Department. There is opportunity for a great deal of engineering assistance of this kind, and it is a pleasure to report that work done by the College in surveying farms for drainage does not reduce the amount of the work of professional drainage engineers but rather increases it by stimulating interest in the subject. Arrangements have been perfected so that students taking advanced work in farm engineering may work on these extension problems, thus making it possible to greatly increase the capacity of the existing staff for extension work.

RECOMMENDATIONS

As the Department has developed two distinct lines of work in which it can be of special assistance to the farmers of the State, the request is made that for the coming year the Department be given an appropriation from the extension fund for this work.

HOWARD W. RILEY,
Assistant Professor of Farm Mechanics.

DEPARTMENT OF AGRICULTURAL CHEMISTRY

The work of the Department of Chemistry in its Relations with Agriculture, during the past year, has been chiefly along the routine line of instruction to students registered for the several courses. In addition, this Department has cooperated with other departments of the College in making chemical analyses of materials submitted by them.

One line of research has been completed at least sufficiently to make a published report. This is now forthcoming. It deals with certain chemical changes in hens' eggs as influenced by the composition of the rations fed to the hens.

The investigation of the moisture and sulfur content of evaporated fruit is still in progress.

The only extension work that could be done consisted in the examination of various agricultural materials that were sent in by residents of the State. Among the examinations made, as shown in the list below, is the striking item of sixteen poison cases. The material sent consisted of parts of the internal organs of cattle, horses, swine, and poultry. Losses due to poisoning seem to be increasing. It is difficult to determine whether the poisoning is accidental, owing to a more general use of poisonous sprays, or whether it is intentional. The demand for examinations of soils for acidity, looking toward liming, is also increasing.

A classified list is submitted below, showing samples examined in the laboratory and reported on either to other departments of the College or to individuals in the State:

Acetylene refuse	1
Acid phosphate	3
Apples (evaporated)	1
Ashes	5
Beans	1
Beets (mangels)	5
Bone (burned)	1
Charcoal	5
Chemicals	3
Condition powders	1
Copper cable	1
Eggs	14
Feeds	14
Fertilizers	11
Grits	2
Lead arsenate	3
Leather scrap	1
Lime	7
Limestone	5
Manures	5
Maple sirup	1
Marl	12
Meat scrap	4
Milk	1
Milk refuse	1
Muck	13
Mustard meal	2
Oats	28
Ore	1
Paints	1

Phosphate rock	1	Soap	1
Poison cases	16	Soils	65
Polish (silver)	1	Soot	1
Raisin seeds	1	Stack stuff	1
Rock	4	Sulfur	1
Sand	1	Tankage	1
Sawdust	1	Tannery refuse	1
Seaweed	3	Vinegar	13
Shavings (wood)	1	Water	8
Shells	1		
Silage	16	Total	292
Slag	1		

GEORGE W. CAVANAUGH,
Professor of Chemistry in its Relations with Agriculture.

DEPARTMENT OF RURAL ART

TEACHING

Opportunity for expansion and a more comprehensive handling of our work was made possible during the past year through the addition to our staff of E. Gorton Davis, who was engaged as assistant professor at the beginning of the year.

It seemed wise to again accept for the year the drafting space in White Hall, which had been so courteously granted to the Department in previous years by Professor Martin of the College of Architecture. Professor Martin arranged for us additional special lecture-room and exhibition space, also, which we used conjointly with the College of Architecture. We set up our own lantern for slides, which was a further convenience. During the year our instruction — other than that in plant materials, which was conducted in the College of Agriculture — was given in White Hall.

The writer feels that an index to our progress and to the efficiency of the instruction is the character of work that the students are doing. The writer believes that the student work of the past year is, in general, quite the most meritorious that we have been able to command thus far, and that it has attained a satisfactory standard.

In the middle of the year the moving of our office in the College of Agriculture to a better room made possible the organization, arrangement, and indexing of much technical material, such as reference reading, collections of illustrations, lantern slides, and the like. The collection of a set of photographs adequately illustrating plant materials was undertaken and is in progress.

During the year a restudy of our curriculum, in the light of experience, resulted in a somewhat revised program as published in the present catalog of the College. This restudy included an effort to better adapt several of our courses to election by the general student: Course 2, Elementary Theory, which is in particular an abstract and analytical study of natural landscape; Course 3, History of Landscape Design, which seemingly is the most popular elective course; Course 4, Theory and Æsthetics of Landscape Design, also a course in which we have had many general students in the past; Course 13, Elementary Planting Design, which is adapted especially to the student wishing, as an amateur, a knowledge of the principles underlying the use of plant materials. The work in the last-named course is the foundation for more advanced study in the same subject.

Course 10, Plan Evolution — a new course that has been introduced for technical students — is a series of lectures supplementing the drafting-room work in junior design, and involving the presentation of much subject-matter relating to the landscape plan which has previously been covered, for the most part, only by criticisms in the drafting-room.

Another new course — 39, Gardening — is being given in conjunction with the Department of Horticulture. It furnishes opportunity for the garden enthusiast to work out in a practical way some phases of gardening of particular interest to himself.

Two other changes of importance were made. The name of the Department was changed from Rural Art to Landscape Art. It is believed that the new name is more truly expressive of what the Department is, and that it is more generally intelligible, covering adequately for the prospective student the general character of the field of our activity. The other change was the establishment of a special advanced degree, Master in Landscape Design. We now have two students, graduates of the College in 1912, registered for this degree.

The writer, in his report for 1910–1911, mentioned instruction in civic design as a necessary future addition to the departmental list of courses. The staff of the Department is engaged in active preparation for the offering of such a course. However, the course involves material of such importance and an expenditure of so much time, thought, and money, both in its preparation and in its mode of treatment, that it has been deemed wise to regard the addition of this subject as a future expansion, attempting it in the not-too-distant future but at a time when from the outset the subject may be treated comprehensively.

Special lectures and trips

During the year 1911–1912 the Department arranged for fewer special lectures by outside men than in previous years, because of the limited funds at its disposal and the need of expenditures for classroom equipment.

At the close of the college year last June an inspection trip of several days duration was conducted. More than one hundred of the most representative places in the Hudson River section and on Long Island were visited. A distance of approximately five hundred miles was covered by automobile. Every effort was made toward economy, and the average individual expense for ten students, for a period of four days, amounted to $20.

EXTENSION

In spite of the fact that no special funds have been available, some work in the field of extension was undertaken along two rather definite lines, as follows:

1. In cooperation with the general Extension Office a number of granges and rural school meetings were addressed on the general subject of landscape improvement. A member of the staff also met the school commissioners of several districts. A method of presenting data to us by rural school teachers — data on which we might base recommendations for improvements — was outlined to the Erie county commissioners and the county superintendents, Erie county being chosen for the beginning of the work of improving particular plots. To several Erie county schools, from which we have thus far received data, we propose to send recommendations in the near future.

2. In another line of extension work we have dealt directly with the Fiscal Supervisor of State Charities at Albany, and a definite start was made toward the development and care of grounds about the several institutions under his charge. This work is still in progress.

In all our extension efforts, however, we are decidedly limited by the fact that we have no special extension funds and no person specially assigned to the conducting of such work.

As regards publications, we propose to issue shortly a series of bulletins covering certain matters pertaining to the problems of the home grounds. These bulletins will aid both in the saving of time and in greater thoroughness in answering questions. The large correspondence occasioned by queries from people of the State makes urgent the publishing of bulletins; and it has also suggested the subject-matter most in demand.

The bulletins that we have in mind are: First, a revision of a bulletin issued several years ago by the Department on "The Care of Street Trees," so that it will cover more fully the care and use of trees in general; second, a bulletin treating in an elementary way the problem of planting small residence properties; third — and apparently most important, judging from the number of inquiries — a bulletin on the making and care of lawns.

COLLEGE PLAN AND ARBORETUM

During the year the Department was given supervision of the grounds about the College and of the preparation of plans for future development. Work on such plans has been conducted for some time past, in consultation with the Director and the Building Committee.

We have also made a very definite start in the development of an arboretum for the College, on land assigned for that use. Many thousands of young plants and cuttings are now in the ground, and other plants are being grown from seed. Plantings of evergreens and selected groups of conifers, lilacs, and other plants have been made possible through the generosity of several nurserymen.

RECOMMENDATIONS

The Department has this fall moved all that part of its work formerly conducted in White Hall to rooms in the main building of the College of Agriculture. We consider that we are now well situated for the immediate future. However, we anticipate the need within two years time of a much more extended equipment and larger quarters.

A great loss that we feel in leaving our former quarters in the College of Architecture is the ready access to the excellent library of that College, which contains much material pertinent to our work.

BRYANT FLEMING,
Professor of Rural Art.

DEPARTMENT OF DRAWING

TEACHING

For the past year the number of students taking work in the several courses in the Department of Drawing was as follows:

Course	First semester	Second semester
1 Elementary Mechanical Drawing	30	32
2 Elementary Freehand Drawing	12	24
3 Applied Drawing	14	12
5 Perspective	......	4
7 Freehand Sketching	9	3
Total	65	75

Adding the number for both terms gives a total of 140, as against 130 for the preceding year. This shows a gain of 10, or nearly eight per cent.

Every graduate of this College should have had a course in mechanical drawing, enabling him to read readily building plans and simple machine drawings. That the general student realizes his need for such knowledge is shown, not only by the increased attendance, but also by the fact that many students have been prevented from registering in this course because of conflicts with other courses scheduled at the same hours. In order to meet this demand additional classes must soon be formed, and this will require increased teaching force.

Scientific classification, and all judging, or scoring, are based on a consideration of relative size, form, color, and position; and freehand drawing is the only course in which the student makes a study of relative size, form, color, and position as such. Drawing is form study, and so are all the morphological sciences; hence the value of drawing to the scientist. The courses in freehand drawing (2, 3, 5, and 7) are intended especially to aid the scientific student in his graphic expression of form. In these courses, as shown above, about forty students were registered for each term.

Heretofore instruction in the perspective drawing required of the students in landscape art has been given in the College of Architecture. Accommodation there being too limited, it became necessary for this Department to undertake such instruction. As a result, Course 5 has been added. This is practice in pictorial representation from plan and description or from specifications.

The equipment of the Department is being added to, as need arises, in the form of artificial fungi, of plant models, mounted insects, birds, and animals for the freehand courses, and of machine parts and simple demonstration apparatus for the mechanical drawing.

RECOMMENDATIONS

Any recommendations that the Department might be disposed to make would be in the matter of appropriations. As with all other departments, so with this; more funds are needed, especially for cabinets for storing students' materials and instruments, and for demonstration apparatus in the mechanical courses. More funds are required also for facsimile reproductions of good paintings, suitably framed, for aiding in the development of the students' appreciation of good art.

W. C. BAKER,
Assistant Professor of Drawing.

DEPARTMENT OF RURAL ECONOMY

TEACHING

Teaching in the Department continues the same as last year. The courses lately added to the curriculum have had more than a normal increase in numbers, especially the course in cooperation. This course is beginning to appeal to many as a new avenue of effort in both town and country.

The normal growth of students in the Department makes it impossible to give as much personal attention to each as is desirable.

INVESTIGATION

Aside from library work on problems arising mainly in the lecture courses, but little has been done in investigation. In connection with the study of cooperation in New York (as an extension enterprise), considerable time has been spent in investigation.

EXTENSION

The main efforts of the Department have been centered on the preliminary work looking toward a study of the whole problem of cooperation, mainly in the State of New York. Within a short time the gathering of data will begin all over the State, and it is expected to have available not only historical data but also such information as will make easier the forwarding of all cooperative efforts in the State; in other words, to have a center where live data on all kinds of cooperative effort may be found.

The means available have not been sufficient to encourage a man to take up this work. It is hoped that this vital field may be occupied by a man temperamentally and educationally fitted for the work, and that the remuneration will be attractive enough to make it worth while. With the data that it is proposed to collect, and the best library on the subject in the country, the cause of cooperation would be much forwarded and the College could be made the center of such enterprise.

RECOMMENDATION

As has been said in every previous report, the greatest needs of the Department are: space to accommodate the undergraduate students, and the graduate students who are now turned away; an opportunity to develop the teaching and investigative work; and provision for the extension work.

Teaching is now done in four different rooms in three different buildings, and two of these buildings do not belong to the College of Agriculture. A handicap such as the Department is now working under should not exist. Not only does the teaching lack many things, due to the fact that all lectures are given under conditions such as prevent the use of even the meager resources of the Department, but laboratory work could with advantage be introduced and, indeed, in such a field as cooperation to train for active work it is absolutely necessary.

Graduate students cannot be given the fundamental courtesies that may be expected even under trying conditions.

The Department of Rural Economy needs a whole floor, of the size of those in the Main Building, in order to do justice to the students that it now has. Not even the general business — not to mention the extension work — can be looked after under prevailing conditions.

The staff of the Department should be increased by an instructor for the teaching work, to be trained for a division of the field along social lines. The necessity for an extension man will be more pressing as soon as the data to be collected begin to return. The Department cannot in the future continue its extension efforts without the constant assistance of a typewriter operator.

Other needs of the Department are illustrative material, books, and supplies.

G. N. LAUMAN,
Professor of Rural Economy.

DEPARTMENT OF HOME ECONOMICS

TEACHING

In 1911–1912 the teaching staff in the Department of Home Economics consisted of two professors, one assistant professor on half time, two student assistants for the entire year, and one extra student assistant during the Winter-Course.

The number of courses offered by the Department was as follows: First term, 8; second term, 10; Winter-Course, 5.

The number of teaching hours was: First term: lectures, 16; laboratory periods, 11. Second term: lectures, 20; laboratory periods, 12. Winter-Course: lectures, 9; laboratory periods, 8.

The registration for the year appears below:

Freshmen	36
Sophomores	24
Juniors	12
Seniors	7
Special students	3
Students from other departments and colleges	57
Winter-course students	32
Total	171

The number of students registered for food laboratory was:

Winter-Course	32
Course 1	36
Course 3	32
Course 6	8
Total	108

Five courses in home economics were offered in the Summer School. The work seemed to fill a decided need. It is believed that another year the summer-school work should be graded as it now is in regular courses. The following number of students registered:

Course A	38
Course B	25
Course C	30
Course D	15
Course E	7
Total	115

One new course, The Field of Home Economics, was added to the department curriculum in response to the need of keeping freshmen in closer touch with the Department.

A very close, although not avowedly official, affiliation was made with the Department of Domestic Science of the public schools of Ithaca, through Miss Snook, the teacher of domestic science in those schools. The students in the Department of Home Economics were thereby enabled to have practical experience in teaching, each senior student having charge of a class for one period each week during the school year. It is hoped that the connection with the public school may soon become an established and officially recognized one. We feel that we owe a debt of gratitude for the time and interest which Miss Snook has given to the Department.

The Department showed its growth over the previous year very markedly, both in the crowding of classrooms and laboratories and in the extra strain of work needed for the arrangement of schedules and supervision of work done. The teaching force of the Department was entirely inadequate for the amount of work to be done.

INVESTIGATION

Work of an investigative nature has been impossible to any extent, as will be seen by a study of the first page of the report of this Department. The small teaching force and the limited number of workers were all needed to concentrate on the problems of teaching and executive work. Investigations concerning work in other States, opportunities for trained women, principles in canning and preserving fruits and vegetables, have been promoted to some extent. No important investigation is possible in this Department under present limiting conditions.

EXTENSION

Extension in home economics has been promoted by means of (a) Reading-Course lessons, one each month; (b) lectures before granges, institutes, special meetings, farm trains, reading clubs, and the like; (c) correspondence with members of the Reading-Course; (d) field work in rural centers with groups of women, organized as clubs, conducting club studies in home economics in various communities of the State; (e) a course of lectures during Farmers' Week, on subjects relating to home economics, for an organization called the Homemakers' Conference; (f) a three-months Winter-Course in Home Economics, consisting of laboratory practice and daily lectures; (g) exhibits at the State Fair and at the Congress of Hygiene and Demography; (h) bread and clothing contests among the farmers' wives' clubs.

Number of meetings attended	163
Number of addresses given	237
Number of demonstrations given	25
Number of letters written	1,987

Cornell Reading-Course for the Farm Home

The following lessons were published in the Cornell Reading-Course for the Farm Home:

1. The care and feeding of children.— Part I. Flora Rose.
3. The care and feeding of children.— Part II. Flora Rose.
5. Household decoration. Helen Binkerd Young.
7. Household furnishing. Helen Binkerd Young.
9. Reading in the farm home. Martha Van Rensselaer and Caroline Webster.
11. The laundry. Flora Rose.
13. Cornell study clubs. Martha Van Rensselaer and others.
15. Principles of jelly-making. N. E. Goldthwaite.
17. The preservation of food in the home.— Part I. Flora Rose.
19. The preservation of food in the home.— Part II. Flora Rose.
21. The preservation of food in the home.— Part III. Flora Rose and others.
23. Rules for cleaning. Mary Urie Watson.

Below is given a summary statement, showing the number of readers and of study clubs:

Number of readers October 1, 1911	17,713
Number of readers at time of revision of mailing list, April, 1912	22,014
Renewals, April 1 to October 1, 1912	6,730
New readers during year	7,957
Number of members of Cornell study clubs	1,354

Total number of readers September 30, 1912	16,041
Number of study clubs October 1, 1911	46
Number of study clubs September 30, 1912	53
Discussion papers returned	1,396
Requests for bulletins from residents of New York State	7,342
Requests for bulletins from residents of other States	541
Total number of requests for bulletins	7,883

The numbers of readers, by counties, are shown in the following list:

Counties	New readers (April-October 1912)	Renewals	Total
Albany	217	70	287
Allegany	136	126	262
Broome	140	82	222
Cattaraugus	190	188	378
Cayuga	171	154	325
Chautauqua	283	269	552
Chemung	52	91	143
Chenango	194	90	284
Clinton	187	61	248
Columbia	122	53	175
Cortland	96	100	196
Delaware	100	88	188
Dutchess	109	80	189
Erie	245	276	521
Essex	149	36	185
Franklin	40	65	105
Fulton	31	16	47
Genesee	61	146	207
Greene	30	40	70
Hamilton	3	1	4
Herkimer	115	86	201
Jefferson	196	137	333
Kings	125	50	175
Lewis	87	44	131
Livingston	84	84	168
Madison	117	112	229
Monroe	168	214	382
Montgomery	59	44	103
Nassau	35	36	71
New York	246	120	366
Niagara	74	125	199
Oneida	177	188	365
Onondaga	311	253	564

Counties	New readers (April-October 1912)	Renewals	Total
Ontario	137	135	272
Orange	135	79	214
Orleans	56	56	112
Oswego	161	199	360
Otsego	448	119	567
Putnam	21	11	32
Queens	65	36	101
Rensselaer	96	67	163
Richmond	8	31	39
Rockland	27	13	40
St. Lawrence	114	174	288
Saratoga	184	99	283
Schenectady	86	33	119
Schoharie	84	37	121
Schuyler	38	67	105
Seneca	62	87	149
Steuben	173	160	333
Suffolk	125	90	215
Sullivan	46	28	74
Tioga	68	105	173
Tompkins	185	433	618
Ulster	102	71	173
Warren	96	19	115
Washington	197	83	280
Wayne	117	150	267
Westchester	111	54	165
Wyoming	74	93	167
Yates	122	68	190
Out-of-state	440	588	1,028
Foreign	29	20	49
Total	7,957	6,730	14,687
Cornell study clubs (see following report)			1,354
Grand total			16,041

In the Cornell study clubs the registration by counties was as follows:

Counties	Readers
Allegany	23
Cattaraugus	46
Cayuga	103

Counties	Readers
Chautauqua	17
Chenango	10
Clinton	29
Delaware	24
Erie	36
Greene	15
Herkimer	28
Jefferson	32
Madison	32
Monroe	179
Niagara	53
Oneida	156
Onondaga	93
Ontario	23
Oswego	84
Otsego	19
St. Lawrence	53
Saratoga	51
Schoharie	46
Schuyler	45
Seneca	32
Sullivan	12
Tompkins	60
Washington	29
Yates	24
Total	1,354

RECOMMENDATIONS

In visiting rural sections of the State, one condition which was found to need changing was that of the status of the girl and the woman on the farm. It is believed that, until the woman's time is recognized as having actual commercial value, very little will be done to give her greater opportunities than she now has. Such a change could be stimulated by establishing in the Department short courses that would provide technical training along various lines especially adapted to farm women and girls. It is recommended that when the departmental appropriation is asked for, this be taken into account, as we believe it will prove to be the most progressive piece of extension work in which the Department could engage.

It would be desirable to add to the instruction of country girls such plays and games as would increase health, efficiency, and the enjoyment of pastoral life, rather than to supply solely the knowledge of work that in itself makes the body healthy rather than alive.

Contests in bread-making and in some other household processes should be instituted throughout the State, because at the present time the standards are low.

More work should be done for country girls by the Department of Home Economics, since the work providing for country women is already well founded. The study of domestic science should begin earlier, in order not to have to change so radically the ways of the housekeeper.

As much needs to be done for country girls as is now done for country boys, in order to give contentment in housework and knowledge of the best methods of doing the work.

With the new building, the need for development is now very urgent. Applicants for admission to the Department, as well as old students, are demanding courses which are an established part of other colleges and which they have a right to expect from us. The reputation of the Department is at present in advance of what it can present. We believe that unless the teaching force can be materially increased and diversified another year, the work of the Department will suffer seriously. The maintenance of the building will be a much more serious consideration than the maintenance of our present single floor, and we therefore recommend that the maintenance appropriation be materially increased.

It is recommended that the old Tailby house — now the Home Economics Lodge — be purchased from the University to be used as a practice house for the Department. The house has already been equipped as a laboratory for students in nutrition, household management, and house decoration, and will be so used during the coming year.

FLORA ROSE,
MARTHA VAN RENSSELAER,
Professors of Home Economics.

DEPARTMENT OF METEOROLOGY

(In cooperation with the United States Weather Bureau)

TEACHING

During the past year 201 students have received instruction in meteorology and climatology through the several courses given in this Department. The numbers registered for the various courses are as follows: General course in Meteorology and Climatology, given during the second term, 167; Summer School in Agriculture, 32; Graduate School, 2. The work of teaching in this Department has been directed toward giving students, first, a comprehensive understanding of the fundamental principles of the science, and second, suggestions as to the application of those principles to agricultural practice.

INVESTIGATION

As in past years this Department, under direction of the United States Weather Bureau, has had supervision of about one hundred cooperative meteorological stations distributed throughout the State, where records of temperature, weather, and precipitation are made. The data thus obtained have been discussed and published in tabular form in the Monthly Weather Review published at Washington, District of Columbia.

Several new stations have been established during the year for the investigation of local climatological problems. Among the more important may be mentioned two stations located at Letchworth Park. It is believed that the records obtained from these stations, particularly in connection with the extensive reforestation that is being undertaken by the State in that locality, will prove of considerable value. Stations have also been established in cooperation with the state agricultural schools at Morrisville and Alfred and with the Forest Ranger School at Wanakena. It is believed that the meteorological equipment at these schools should be increased gradually until full and complete records are made. There is reason to hope that the cooperation of the United States Weather Bureau in this plan may be obtained.

Recent studies of climatic records made in this State, particularly those relating to the occurrence of injurious frosts, have revealed the need for detailed phenological records. Accordingly, in the spring of 1912 blanks and instructions were sent out to a number of observers whose cooperation was solicited. Nineteen of these observers responded, furnishing valuable data for future reference. Judging from this year's experience in securing phenological records, it is believed that it will be possible to regularly obtain records of sufficient interest to justify the publication of a phenological chart of the State for each season.

In cooperation with the Department of Plant Pathology, eight field laboratories have been equipped with meteorological instruments by means of which daily records have been made during the past season.

EXTENSION

The preparation of Experiment Station Bulletin 316, "Frosts in New York," was the principal accomplishment in extension work during the year. This bulletin discusses conditions favorable to the formation of frost, including the differences in liability to frost resulting from differences in elevation, exposure, soil, drainage, and the like; methods of forecasting frost, and methods of protecting from and reducing injury resulting from frost. In addition, tables are given summarizing the records made at 115 stations in New York, indicating the frequency of killing frosts, by periods of five days each, throughout the spring and fall.

WILFORD M. WILSON,
Professor of Meteorology.

EXTENSION DEPARTMENT

TEACHING

The teaching work of the Department for the past year included three courses: Extension 1 and 2, as outlined in the College Announcement, and Extension 14 in the Winter-Course. These courses aim to bring the students into closer touch with agricultural affairs in their communities, through study of the principles of organization and through practice in writing on and presenting country-life subjects. Parliamentary practice is given in connection with Extension 2, in order that our students may be able to take their part in public meetings. The registration in Extension 1 of 57 students, in Extension 2 of 33 students, and in Extension 14 (in the Winter-Course) of 35 students, taxed to the utmost the resources of the Department; since the laboratory work, or practice, consumed five laboratory periods a week for course 1, two laboratory periods a week for course 14, and four laboratory periods a week for course 2 requiring individual attention to each student. Last year there was an increased interest in the Eastman Stage in public speaking. Nearly fifty entered the competition, with the result that the Third Annual Eastman Stage surpassed all former contests.

EXTENSION

Lectures

Lectures by members of the college staff were given on request at county and subordinate granges, fairs, agricultural and horticultural clubs, farmers' and teachers' institutes, dairymen's and poultrymen's associations, schools, churches and Christian associations, farmers' picnics, and Farmers' Week. Departments sometimes give lectures on their own funds and do not always turn in reports to the Extension Office. In the departmental reports the figures on such detached lectures should appear. Directly on the funds of this Department, 274 lectures, with 30,341 persons in attendance, were given last year in 48 counties, as shown below:

Counties	Attendance	Meetings
Albany	535	6
Allegany	610	2
Broome	50	2
Cattaraugus	430	3
Cayuga	1,112	11
Chautauqua	3,512	19
Chemung	542	6

Counties	Attendance	Meetings
Chenango	560	5
Clinton	808	10
Columbia	510	2
Cortland	260	3
Dutchess	161	4
Erie	1,296	9
Essex	150	2
Genesee	540	5
Greene	210	2
Herkimer	515	4
Jefferson	1,745	5
Livingston	122	2
Madison	1,870	6
Monroe	2,450	15
New York	395	5
Niagara	1,225	4
Oneida	1,064	18
Onondaga	420	7
Ontario	450	7
Orange	204	5
Orleans	301	5
Oswego	475	6
Otsego	225	4
Rensselaer	12	1
St. Lawrence	217	2
Saratoga	130	2
Schenectady	435	4
Schoharie	90	2
Seneca	224	3
Steuben	60	1
Suffolk	1,808	13
Sullivan	75	1
Tioga	300	3
Tompkins	880	26
Ulster	330	5
Warren	490	5
Washington	1,058	8
Wayne	340	7
Westchester	490	3
Wyoming	75	1
Yates	580	3
	30,341	274

The following meetings were arranged by the Department during the year:

Town	Date	Nature of meeting	Speakers from College
Marathon	Oct. 2	Field meeting	Professor Fippin
West Henrietta	Oct. 5	Lecture	Professor Cavanaugh
North Rose	Oct. 6	Lecture	H. B. Knapp
Jacksonville	Oct. 7	Pomona Grange	Professor Tuck and R. H. Wheeler
Holland Patent	Oct. 18	Lecture	Professor Savage

Town	Date	Nature of meeting	Speakers from College
Albany	Oct. 18	Conductors' Conference	Professor Tuck
Sherburne	Oct. 27	Lecture	Professor Tuck
North Rose	Nov. 3	Lecture	E. M. Tuttle
Watertown	Nov. 10	Lecture	Professor Tuck
Sherburne	Nov. 15	Lecture	Professor Wing
Cherry Creek	Nov. 20–25	Extension school	Professor Minns Professor Wing John W. Spencer Professor Ross A. C. King
Ithaca	Nov. 21–22	Normal Institute	Institute workers
Holland Patent	Nov. 24	Lecture	Professor Fippin
Oaks Corners	Nov. 24	Lecture	Mr. Knapp
Aurora	Nov. 24	Lecture	Mrs. Comstock
Elbridge	Nov. 28	Lecture	Mr. King
North Rose	Dec. 1	Lecture	Professor Cavanaugh
Wyoming	Dec. 4–9	Extension school	Professor Minns Professor Hopper Professor Barrus Mr. King Professor Cavanaugh C. H. Myers
Alden	Dec. 4–9	Extension school	L. J. Cross Mr. Myers Mr. King Professor Barrus Professor Hopper
Albion	Dec. 5	Lecture	Professor Fippin
Nichols	Dec. 7	Lecture	Dr. W. M. Wilson
Derby	Dec. 11	Lecture	Mr. King
Oswego	Dec. 14	Lecture	Mr. King
Honeoye Falls	Dec. 14	Lecture	Professor Tuck
Millbrook	Dec. 15	Lecture	Professor Wing
Ballston Center	Dec. 18–23	Extension school	Mr. King Professor Hopper R. P. Trask
Holland Patent	Dec. 19	Lecture	Mr. Cross
Syracuse	Dec. 28–30	Lectures	Professor Warren
Rochester	Jan. 3–5	Fruit Growers' Association	Professor Whetzel Professor Wilson Professor Reddick Professor Barrus Professor Herrick Professor Riley Professor Crosby
Oaks Corners	Jan. 6	Lecture	L. M. Hurd
Falconer	Jan. 8–13	Extension school	Mr. King Professor Hopper Professor Fippin Professor Minns
Glens Falls	Jan. 12	Lecture	Professor Gilbert
Canandaigua	Jan. 12	Lecture	Mr. Wheeler
Truxton	Jan. 15	Farmers' Institute	Mr. King
Little York	Jan. 15	Farmers' Institute	Professor Tuck
Lowville	Jan. 15–20	Extension school	Professor Stone Professor Hopper Mr. Cross E. S. Guthrie Mr. Myers

Town	Date	Nature of meeting	Speakers from College
Watertown	Jan. 15–20	Extension school	Professor Fippin Professor Bentley Professor Hopper Mr. Guthrie Mr. Myers
Preble	Jan. 16	Farmers' Institute	Mr. King
Marathon	Jan. 17	Farmers' Institute	Professor Tuck
Holland Patent	Jan. 17	Lecture	Mr. Guthrie
Virgil	Jan. 17	Farmers' Institute	Mr. King
Freetown Corners	Jan. 18	Farmers' Institute	Mr. King
Cincinnatus	Jan. 18	Farmers' Institute	Professor Tuck
Cortland	Jan. 19	Farmers' Institute	Professor Tuck Professor Wing Mr. King
Texas Valley	Jan. 20	Farmers' Institute	Mr. King
Belleville	Jan. 20	Lecture	Professor Fippin
Slaterville	Jan. 22	Farmers' Institute	Professor Hopper Professor Ross Professor Cavanaugh
Danby	Jan. 22	Farmers' Institute	Mr. King
New Hackensack	Jan. 23	Lecture	George Miller
McLean	Jan. 23	Farmers' Institute	Professor Hopper T. E. Schreiner Professor Tuck
North Lansing	Jan. 23	Farmers' Institute	Mr. King Professor Ross
Groton	Jan. 24	Farmers' Institute	Professor Hopper Professor Stocking
Rochester	Jan. 24–27	Fruit Growers' Association	Professor Herrick Professor Crosby Professor Barrus Professor Whetzel Professor Reddick Professor Wilson Professor Riley
Lincoln Park	Jan. 25	Lecture	Mr. Knapp
Trumansburg	Jan. 25	Farmers' Institute	Mr. King Professor Hopper
Enfield	Jan. 26	Farmers' Institute	Mr. King Professor Hopper W. G. Krum Mrs. Harrington
Honeoye Falls	Jan. 27	Lecture	Professor Fippin
Newfield	Jan. 27	Farmers' Institute	Professor Hopper Mr. King Mr. Guthrie Mr. Krum
Riverhead	Jan. 29–Feb. 10	Extension school	Professor Stone Mr. Trask Professor Cavanaugh Professor Barrus Mrs. Harrington
Middlesex	Jan. 29	Farmers' Institute	Professor Tuck Professor Hopper Professor Bentley Mr. King
Branchport	Jan. 30	Farmers' Institute	Mr. King Professor Hopper

Town	Date	Nature of meeting	Speakers from College
Rushville	Jan. 30	Farmers' Institute	Professor Tuck Professor Bentley Professor Hopper Mrs. Harrington
Penn Yan	Jan. 31	Farmers' Institute	Professor Tuck Professor Bentley Professor Hopper Mr. King Mrs. Harrington
Stanley	Jan. 31	Woodlot inspection	Professor Bentley
Gowanda	Feb. 1	Lecture	Mr. Knapp
Bellona	Feb. 1	Farmers' Institute	Professor Tuck Mr. King Professor Bentley Professor Hopper Mr. Krum
Dresden	Feb. 2	Farmers' Institute	Professor Tuck Professor Hopper Professor Bentley
Barrington	Feb. 2	Farmers' Institute	Mr. King
Dundee	Feb. 3	Farmers' Institute	Professor Tuck Professor Hopper Mr. King
Buffalo	Feb. 3	Lecture	Professor Cavanaugh
West Chenango	Feb. 8	Lecture	Professor Hopper
Otego	Feb. 9	Lecture	Mr. Guthrie
Gardenville	Feb. 9	Lecture	Paul Work
Buffalo	Feb. 10	Lecture	Professor Fippin
Gardenville	Feb. 10	Lecture	Mr. Work
Fredonia	Feb. 12–17	Extension school	Mr. King Mr. Hurd Mr. Cross
Albion	Feb. 15	Lecture	Professor Wing
Waterloo	Feb. 15	Lecture	Mr. Cross
Hancock	Feb. 16	Lecture	Mr. Krum
Buffalo	Feb. 17	Lecture	Mr. King
Vestal	Feb. 17	Lecture	Professor Rogers
West Henrietta	Feb. 17	Lecture	Professor Hopper
Walton	Feb. 17	Lecture	Mr. Krum
Ithaca	Feb. 19–24	Farmers' Week	
Troy	Feb. 24	Lecture	Mr. King
Rushville	Feb. 24	Lecture	Mr. Hurd
Kinderhook	Feb. 26– March 2	Extension school	Professor Fippin Mr. Trask Mr. King Professor Barrus
Mountainville	Feb. 26– March 2	Extension school	Professor Barrus Mr. King Mr. Hurd Mrs. Harrington
Albany	March 2	Lecture	Mrs. Comstock
Wampsville	March 2	Lecture	R. E. Deuel
West Henrietta	March 2	Lecture	Professor Livermore
McGraw	March 2	Inspection	C. E. Leighty
Clifton Springs	March 5	Lecture	Professor Gilbert
Derby	March 11	Lecture	Mr. Krum
Sodus Center	March 11	Lecture	Mr. Cross
Amenia	March 15	Lecture	Professor Wing
Auburn	March 16	Lecture	Miss Browning

Town	Date	Nature of meeting	Speakers from College
Eldred	March 21	Lecture and inspection	Professor Bentley
Tully	March 21	Lecture	Professor Savage
Marathon	March 22	Farmers' Institute	Professor Tuck Professor Stone Professor Wing
Oneida	March 23	Lecture	H. L. Ayres
Silver Creek	March 23	Lecture	Mr. Work
Perry	March 26	Lecture	Mr. Krum
Oswego	March 29	Lecture	R. D. Anthony
Conklin	March 29	Lecture	Professor Savage
Albany	March 30	Lecture	Professor Rogers
Harpursville	April 2	Delaware & Hudson Farm Train	Mr. Krum Mr. King Mrs. Harrington Professor Rose Professor Van Rensselaer Professor Wing Professor Crosby Professor Barrus Professor Tuck Professor Ogden Professor Minns Professor Savage Miss Nye Mr. Misner Mr. Kent
Afton	April 2		
Bainbridge	April 3		
Oneonta	April 3		
Cooperstown	April 4		
Worcester	April 4		
Cherry Valley	April 5		
Cobleskill	April 5		
Altamont	April 6		
Albany	April 6		
Saratoga Springs	April 8		
Glens Falls	April 8		
Whitehall	April 8		
Greenwich	April 9		
Port Henry	April 10		
Willsboro	April 10		
Plattsburg	April 10–11		
Chazy	April 11		
West Chazy	April 11		
Peru	April 12		
Port Byron	April 3	Lecture	Professor Fippin
Ithaca	April 3	Lecture	Mrs. Harrington L. B. Cook Profesor Bentley
Derby	April 8	Lecture	Mr. Knapp
Palmyra	April 9	Orchard inspection	Mr. Knapp
Seneca Falls	April 10	Orchard inspection	Mr. Knapp
Camillus	April 12	Lecture	Professor H. W. Riley
Sherburne	April 12	Lecture	Professor Rose
Westfield	April 16	Conference	Professor Tuck
Holland Patent	April 17	Lecture	Professor Minns
Cortland	April 19	Conference	Professor Tuck
Ovid	April 20	Two lectures	Professor Rose
Rhinebeck	April 22	Lecture	Mr. Krum
Kinderhook	April 23	Lecture	Mr. Krum
Pulaski	April 24	Conference	Professor Tuck
Watertown	April 25	Conference	Professor Tuck
Barnhards Bay	April 26	Lecture	Professor Minns
Honeoye Falls	April 27	Lecture	Professor Davis
Salamanca	May 2	Conference	Professor Tuck
Jamestown	May 3	Lecture	Professor Tuck
Sodus	May 4	Lecture	Professor Savage
Batavia	May 4	Conference	Professor Tuck
Ithaca	May 6	Conference	Mrs. Hattie Buck Mr. Bigelow Mr. Beardsley Professor Tuck
Middletown	May 7	Lecture and conference	Professor Tuck

Town	Date	Nature of meeting	Speakers from College
Washingtonville	May 7	Lecture	Professor Tuck
Hall	May 11	Lecture	Professor Savage
Little Falls	May 16	Lecture and conference	Professor Tuck
Dryden	May 22	Lecture	Professor Stone
Saratoga Springs	May 23	Lecture	Mr. Krum
Oneonta	May 23	Conference of county agents	Professor Tuck
Little Falls	May 25	Lecture	Professor Van Rensselaer
Ithaca	May 31	Rural school picnic	
Stedman	June 13	Lecture	Mr. Krum
Elmira	June 14	Lecture	Mr. Krum
Buffalo	June 14	Bankers' meeting	Professor Tuck
Ischua	June 18	Lecture	Professor Minns
Syracuse	June 19	Institute conductors	Professor Tuck
Akron	June 21	Lecture	Professor Minns
Wyoming	June 27	Lecture	Professor Tuck
Ithaca	July 10	Lecture	Professor Tuck
Ithaca	Aug. 3	Interlaken grange picnic	
Batavia	Aug. 10	Lecture	Professor Webber
Cincinnatus	Aug. 15	Lecture	Mr. Krum
Silver Lake	Aug. 16	Lecture	Professor Cavanaugh
Ithaca	Aug. 20	Picnic from Cazenovia and De Ruyter	
Oswego	Aug. 22	Lecture	Professor Barrus
Alden	Aug. 22	Lecture	Professor Wing
Brocton	Aug. 22	Lecture	Professor Gilbert
Electric Park	Aug. 24	Lecture	Mr. Krum
Jamestown	Aug. 24	Lecture	Professor Gilbert
Richford	Aug. 30	Lecture	Professor Minns
Ithaca	Aug. 31	Tompkins county grange picnic	
Searsville	Sept. 4	Lecture	Professor Cavanaugh
Herkimer	Sept. 5–6	Lectures	Professor Stone
Cazenovia	Sept. 17	Lecture	Professor Tuck
Hall	Sept. 28	Lecture	Mr. Anthony

Besides the above, the following conferences were arranged and attended by John W. Spencer:

Town	Date	Nature of meeting
Ithaca	Oct. 13	Conference
Fredonia	Oct. 17	Lecture
Jamestown	Oct. 19	Conference
Jamestown	Oct. 26	Conference
Freeville	Feb. 22	Visit
Westfield	March 25	Lecture
Brocton	March 7–8	Visit to schools
Ripley	March 16	
Ellington	No date given	Lecture
Fredonia	No date given	Conference
Chautauqua	No date given	Lecture
Chautauqua	Grange Day	Lecture
Chautauqua	County Fair	Lecture
Westfield	No date given	Talk to training class
Dewittville	Sept. 5	Pomona Grange

Farmers' Week

The attendance at the Fifth Annual Farmers' Week, held February 19 to 24, exceeded that at previous gatherings. Approximately 2,700 persons were in attendance during the week, representing 19 States in the Union. New York State was represented by 56 counties, with an actual registration of 1,950, or 96.3 per cent of the total registration, which was 2,025. Three hundred and twenty-six lectures were given and nine associations held their meetings at that time. A summarized statement of Farmers' Week follows:

Number of lectures given (approximately)	326
Total registration for the week	2,025
Estimated attendance	2,700
Number of conventions and conferences	9

- Drainage Convention
- Dairy Students' Association
- Experimenters' League Conference
- Homemakers' Conference
- Plant-Breeders' Association
- Rural Church Conference
- Rural School Education
- Students' Association
- Vegetable Growers' Convention

Number of exhibitions	16

- Animal Husbandry
- Books
- Corn Show
- Dairy Industry
- Drawing
- Entomology
- Farm Mechanics
- Home Economics
- Horticulture
- Plant-Breeding
- Plant Pathology
- Plant Physiology
- Rural Art
- Rural School Education
- Soil Technology
- Weather Bureau

Number of contests among students	3

- Eastman Stage
- Winter-Course Stage
- Morrison Debate (Winter-Course)

Number of cooperating lecturers outside the College	85

Summary of attendance:

Counties represented	56
States represented	19
Foreign countries	1
Total registration (actual)	2,025
Total from outside States	75, or 3.7 per cent
Total from New York State	1,950, or 96.3 per cent
Total from Tompkins county	484, or 23.9 per cent
Total from city of Ithaca (not farmers)	128, or 6.3 per cent

Fairs

The demand for educational exhibits at the fairs nearly doubled that of last year. This year 17 departments were represented at the State Fair and a staff of 48 persons was in constant attendance. Educational exhibits went to 26 county fairs, with transportation expenses shared dollar for dollar between the local society and the College. A summary of the State Fair and the county fairs is given below. Estimating the attendance at each county fair at 15,000, with one half seeing the Cornell exhibit, and estimating the attendance at the State Fair at 200,000, with one fourth seeing the Cornell exhibit, we have reached 245,000 persons through the college exhibits at the fairs.

Number of fairs having college exhibits	27

Town	County	Date	Departments exhibiting
Newark Valley	Tioga	Aug. 6–8	Animal Husbandry, Poultry
Fulton	Oswego	Aug. 13–16	Dairy, Public Health
Cortland	Cortland	Aug. 20–23	Entomology
Warsaw	Wyoming	Aug. 20–23	Public Health
Lockport	Niagara	Aug. 26–31	Entomology
Dunkirk	Chautauqua	Aug. 27–30	Poultry, Dairy
Moravia	Cayuga	Aug. 27–30	Public Health
Middletown	Orange	Aug. 27–30	Animal Husbandry
Dongan Hills	Richmond	Aug. 28–31	Entomology
Olean	Cattaraugus	Sept. 2–6	Soils, Animal Husbandry
Warrensburgh	Warren	Sept. 3–6	Entomology
Watertown	Jefferson	Sept. 3–6	Farm Crops
Rome	Oneida	Sept. 3–6	Dairy, Agricultural Chemistry, Poultry
Brockport	Monroe	Sept. 4–7	Public Health
Syracuse (State Fair)		Sept. 9–14	Poultry, Dairy, Animal Husbandry, Forestry, Pomology, Horticulture, Entomology, Home Economics, Plant-Breeding, Plant Pathology, Farm Management, Farm Crops, Plant Physiology, Soils, Agricultural Chemistry, Farm Mechanics, Extension
Plattsburg	Clinton	Sept. 10–13	Entomology
Albion	Orleans	Sept. 11–14	Public Health
Elmira	Chemung	Sept. 16–20	Soils, Entomology
Ithaca	Tompkins	Sept. 17–20	Animal Husbandry
Riverhead	Suffolk	Sept. 17–20	Dairy, Poultry
Cooperstown	Otsego	Sept. 18–20	Agricultural Chemistry
Batavia	Genesee	Sept. 18–21	Entomology, Veterinary Science, Public Health, Plant Pathology
Paris Hill	Oneida	Sept. 19–20	Soils
Washington Hollow	Dutchess	Sept. 19–21	Pomology
Binghamton	Broome	Sept. 24–27	Soils, Animal Husbandry
Lincolndale	Westchester	Sept. 25–26	Dairy
Morris	Otsego	Oct. 1–3	Soils.

Extension schools

During the past year the extension schools were placed on a firm foundation. Thirteen were held in eleven counties, with 483 persons in regular attendance. A summarized statement of the extension schools is given below:

Town	County	Date	Attendance	Expenses	Tuition	Cost per student
Cherry Creek	Chautauqua	Nov. 20–25	17	$70 89	$17 00	$4 17
Alden	Erie	Dec. 4– 9	26	58 33	39 00	2 13
Wyoming	Wyoming	Dec. 4– 9	26	62 72	37 50	2 41
Ballston Center	Saratoga	Dec. 18–23	19	75 06	30 00	3 95
Falconer	Chautauqua	Jan. 8–13	37	103 87	54 00	2 80
Watertown	Jefferson	Jan. 15–20	22	80 94	28 93	3 66
Lowville	Lewis	Jan. 15–20	42	100 11	48 00	2 38
Riverhead	Suffolk	Jan. 29–Feb. 10	53	186 08	108 55	3 51
Fredonia	Chautauqua	Feb. 12–17	49	51 40	73 50	1 25
Kinderhook	Columbia	Feb. 26–Mar. 2	58	203 96	74 50	3 51
Mountainville	Orange	Feb. 26–Mar. 2	56	83 70	84 00	1 49
Keuka Park	Yates	Mar. 4– 9	66	46 37	71 22	70
Delmar	Albany	Mar. 18–20	12	42 79	13 00	3 56
Total			483	$1,166 22	$679 20	$35 52
Average			37.1	89 71	52 25	2 73

Cost per student does not represent net cost to College, as tuition has not been deducted.

Tuition, $1.50 per student for the week.

Net cost to College, $544.82.

Staff consisted of an average of three persons throughout the week.

Farm trains

During the past fiscal year two farm trains were operated: one in connection with the Delaware & Hudson Railroad from Binghamton to Peru, and the other in connection with the New York Central & Hudson River Railroad from Marlboro to Coxsackie on the West Shore Division. To the first train came 19,825 persons; to the second, 498. A summarized statement of the farm trains follows:

DELAWARE & HUDSON RAILROAD, BINGHAMTON TO PERU, APRIL 2 TO 12, INCLUSIVE

Eight coaches:

- Poultry demonstration
- Home Economics demonstration
- Fruit demonstration
- Animal Husbandry demonstration
- Poultry and Home Economics lecture
- Fruit and Animal Husbandry lecture
- Sleeping coach
- Dining coach

Sixteen representatives from College:

Professor Tuck	Professor Ogden
Professor Wing	Mrs. Harrington
Professor Van Rensselaer	Miss Nye
Professor Rose	Mr. Krum
Professor Crosby	Mr. King
Professor Barrus	Mr. Misner
Professor Savage	Mr. Kent
Professor Minns	Mr. Gilkey

Twenty-one stops, as follows, with attendance:

Binghamton	250	Glens Falls	850
Harpursville	500	Whitehall	600
Afton	800	Greenwich	1,550
Bainbridge	850	Port Henry	750
Oneonta	1,500	Willsboro	800
Cooperstown	850	Plattsburgh	1,100
Worcester	875	Chazy	500
Cherry Valley	1,200	West Chazy	450
Cobleskill	1,100	Peru	1,300
Altamont	600		
Albany	2,500	Total	19,825
Saratoga Springs	900		

NEW YORK CENTRAL & HUDSON RIVER RAILROAD, WEST SHORE DIVISION, MARLBORO TO COXSACKIE, MAY 21 TO 24, INCLUSIVE

Two coaches:

Fruit and Animal Husbandry demonstration	Fruit lecture

Five representatives from College:

Professor Tuck	Professor Reddick
Professor Wilson	Professor Crosby
Professor Savage	

Six stops:

Average attendance at each	83
Total attendance	498

Summary

Summarizing the events as given above we have reached approximately the following number of persons:

Single extension lectures	30,341
Farmers' week	2,700
Fairs	245,000
Extension schools	483
Farm trains	20,323
Total	298,847

Farmers' institutes

In addition to the above, 26 farmers' institutes were arranged in Cortland, Tompkins, and Yates counties. The attendance at these institutes was: Cortland, 2,319; Tompkins, 2,280; Yates, 2,040; making a total of 6,639. The towns where the institutes were held are shown below, together with names of the speakers from the College:

Cortland county:

Truxton	Professor Tuck and A. C. King
Little York	Professor Tuck and Mr. King
Preble	Professor Tuck and Mr. King
Marathon	Professor Tuck and Messrs. King, Gilkey, and Buckman
Virgil	Professor Tuck and Mr. King
Freetown Corners	Professor Tuck and Mr. King
Cincinnatus	Messrs. King, Gilkey, and Buckman
Cortland	Professor Tuck, Mr. King, Professor Wing
Texas Valley	Mr. King
Marathon	Professors Tuck and Stone

Tompkins county:

Slaterville	Professors Cavanaugh, Ross, and Hopper
Danby	Mr. King
McLean	Professors Tuck and Hopper, and Mr. Krum
North Lansing	Mr. King and Professor Ross
Groton	Professors Tuck and Hopper, and Mr. Krum
Trumansburg	Mr. King and Professor Hopper
Enfield	Professor Tuck, Mr. King, Professor Hopper, and Mr. Krum
Newfield	Professors Tuck and Hopper, and Messrs. King and Guthrie

Yates county:

Middlesex	Mr. King, Professors Hopper and Bentley, and Mrs. Harrington
Branchport	Mr. King and Professor Hopper
Rushville	Professors Tuck, Hopper, and Bentley, and Mrs. Harrington
Penn Yan	Professors Tuck, Hopper, and Bentley, and Mrs. Harrington
Bellona	Professors Tuck and Hopper, Mr. King, Professor Bentley, Mr. Krum, and Mrs. Harrington
Dresden	Professors Tuck, Hopper, and Bentley
Barrington	Mr. King
Dundee	Professors Tuck and Hopper, and Mr. King

Experimenters' League

During the year an attempt was made to renew the interest in the work of the Experimenters' League. Several new members have been added to the list, and many of the old members have taken up new coöperative experiments with departments at the College. The statement below gives the membership and also the number of experiments arranged with members through the secretary of the league:

Membership by counties:

Albany	12	Herkimer	9
Allegany	10	Jefferson	13
Broome	17	Kings	11
Cattaraugus	10	Lewis	7
Cayuga	29	Livingston	10
Chautauqua	32	Madison	17
Chemung	8	Monroe	30
Chenango	20	Montgomery	8
Clinton	4	Nassau	1
Columbia	14	New York	17
Cortland	18	Niagara	18
Delaware	13	Oneida	34
Dutchess	15	Onondaga	34
Erie	25	Ontario	36
Essex	12	Orange	15
Franklin	11	Orleans	17
Fulton	4	Oswego	26
Genesee	36	Otsego	16
Greene	6	Queens	4

Membership by counties (*continued*)

Rensselaer	12	Suffolk	14
Richmond	5	Sullivan	1
Rockland	4	Tioga	11
St. Lawrence	32	Tompkins	144
Saratoga	13	Ulster	15
Schenectady	10	Washington	5
Schoharie	9	Wayne	15
Schuyler	10	Westchester	10
Seneca	21	Wyoming	13
Steuben	18	Yates	8

Total membership enrolled	989
Number of experiments started and referred to respective departments	88

Farm crops	52
Soils	9
Fertilizers	17
Plant-breeding	9
Poultry	1

County agents

Ten counties have met in conferences and have appointed local representatives to act as agents for their respective counties. These county agents assist in arranging for various extension enterprises for the county, by way of giving advice to the local people and counsel to the College. The county agent affords a means of bringing the needs of the county to the attention of the College and of bringing the College into closer relationship with the people. An example of the work done by one of these county agents since June 7, 1912, is given below:

Number of county agents selected by local people 10

County	Agent
Cattaraugus	F. N. Godfrey, Olean
Chautauqua	S. J. Lowell, Fredonia
Cortland	Miles Peck, Cortland
Genesee	A. H. Call, Batavia
Herkimer	H. A. Crofoot, Little Falls
Jefferson	F. C. Overton, Adams
Orange	Albert Manning, Otisville
Oswego	D. D. Stone, Oswego
Otsego	C. H. Baker, Oneonta
Suffolk	S. C. Hedges, East Hampton

The work taken up in these counties through the county agents included arranging for farm visits, lectures and lecture courses, cooperative experiments, fair exhibits, extension schools, and reading-courses, to be conducted in connection with granges and other clubs. For example, the Herkimer county agent, appointed June 7, 1912, arranged for the following:

Farm visits	7 — Professor Stone and Mr. Krum
Lectures	12 — Professor Stone, Mr. Krum, and Mrs. Harrington
Lecture courses	2 — Pending
Cooperative experiments	Several in Farm Crops
Extension schools	1 — At Poland

Cornell Reading-Course for the Farm

The following statement shows the topics covered by the Cornell Reading-Course for the Farm, together with statistics of readers interested in the course:

	New readers by series	Discussion papers returned
Old series		
I. Soil	278	554
II. Stock-feeding	189	531
III. Orcharding	104	242
IV. Poultry	5	28
V. Dairying	191	472
VI. Farm buildings	85	201
VII. Helps for reading	32	75
VIII. Miscellaneous	115	299
IX. Breeding	99	317
X. Horse production	....	7
New series		
Poultry	1,056	1,958
Soils	167	327
Rural engineering	109	354
Farm forestry	207	416
Horse-breeding	27	217
Dairying	21	32
Orcharding	50	275
Farm crops	157	357
	2,892	6,662
Old readers renewed	2,310	....
Cornell study clubs	13	....

EXTENSION OFFICE MAIL

The number of letters received and sent out by the Department during the past year is as follows:

Letters received	23,968
Letters sent out	24,964

CLASSIFICATION OF MAILING LIST

The great diversity of agriculture in New York State and the increasing demand for the publications of the College has compelled an arrangement whereby the publications will be placed where they will do the most good, thus eliminating the waste that occurs through placing certain bulletins in the hands of persons who are not interested in the particular subject-matter therein contained. During the past year persons on the mailing list for experiment station bulletins have received a classification card to be filled out and returned. Eight subjects have been used in the classification, as follows: apples, commercial floriculture, general farming, grapes, small- tree- and bush-fruits, commercial vegetable culture, poultry, farm home. From the replies a new classified mailing list has been prepared. Special mailing machinery has been installed, which automatically selects and addresses the names registered for any subject. Bulletins of general interest are sent to the entire mailing list as heretofore, but those of special or local interest are sent only to persons who have indicated an interest in the given subjects. For example, Bulletin 317, " Further Experiments on the Economic Value of Root Crops for New York," was mailed on September 26, 1912, to the list of persons who had registered for bulletins on general farming. The saving of bulletins by means of a classified mailing list makes it possible to reach a larger number of persons interested in the subjects treated

RECOMMENDATIONS

The amount of teaching undertaken last year is set forth in the preceding report. This already heavy work has been practically doubled this fall by the registration of 108 students necessitating two additional sections, which now make in all four sections. This teaching enterprise, touching regular and winter-course students, should be organically related to a teaching enterprise outside the College, through the promotion and guidance of discussion of public agricultural questions through farmers' clubs, granges, and other agricultural societies. It should also be related to rural and high school debating societies. To this end, and that our present staff may be relieved so that other extension enterprises may be properly guided, the writer recommends that there be established an assistant professorship in this Department for this specific work. We now have a young man in training who may grow into this work.

While we are arranging a large number of miscellaneous lectures, yet the most effective lecturing is that which we are now doing in logical sequence through lecture series. This work should be continued and expanded so that communities may learn to arrange special work in an orderly and progressive way.

The extension schools have passed the experimental stage. The demand is far in excess of our capacity to meet it. It is recommended that an extension school be placed in every rural county of the State, and eventually in every county. In some cases two should be held in the county because of regional divisions. This, of course, will mean a decided increase in appropriations.

The work of the Experimenters' League has been revised. It is recommended that this work be increased and provision be made for the attention of one person to it.

We have already arranged to aid the people in a serious attempt to secure for themselves a natural way of bringing state aid to their communities through the election of county agents. In the six counties contiguous to or near Tompkins county, there should be immediate relationship with the College. The writer therefore recommends that arrangements be made for an agent in each one of the above-mentioned counties, and that this work be at once pressed forward with the aid of a college automobile. It is further recommended that there be a county agent to connect the needs of the people with the services of the College in every rural county of the State.

The Reading-Course report shows that this extension enterprise is now more firmly etablished than it has been heretofore. The Cornell study clubs should now be arranged and connected with other extension societies. It is recommended that such provision be made for a foreman in the Reading-Course and mailing-room organization as will permit the Supervisor of the Reading-Course to follow well-marked-out itineraries for the establishment of Cornell study clubs.

Further, in connection with the Reading-Course, we should now follow up more actively than ever the suggestion made some time ago by Director Bailey, that mailing-room lists be made alive and a real part of our extension enterprise. This is now under way through the geographical index, which shows the distribution by counties of names on our several lists. Through the use of the county agents, and the lists of our readers by counties, all our extension enterprises may be crystallized by counties through the central point, the county agent. In this way some control might be secured over the avenues of distribution of our literature. Co-operation in the use of our bulletins might be more effectively obtained with grange lecturers. In fact, our relationship to the State would be, not through the State at large, but intimately county by county.

In order to effectively guide all these extension enterprises from the College so that there may be a just distribution of them, more concentrated attention should be given to smaller areas of the State. There should be some means of making effective our present extension plant; but this is impossible with our present force, which is now taxed to the limit. The State should be divided into at least three main divisions — western, northern, and southeastern New York. For each section there should be at the College one person whose duty it would be to arrange for all extension enterprises for the section assigned. The great mass of correspondence, details of routine, travel, and the quick recognition of the needs of even one third of the State, would soon grow beyond the reach of one person. The writer recommends that three such persons be appointed. It is believed that this is the most pressing need of our extension enterprises.

For the past two summers several school teachers have come to the College for particular instruction. They came in contact with certain members of our staff. They wish to continue to study with these persons, but find it impossible to leave their duties during the school year. Therefore, it is recommended that a correspondence course for such teachers be established, and that six lessons be issued in each of the following subjects: Biology, Soil with reference to geology, and Farm Botany.

CHARLES H. TUCK,
Professor of Extension Teaching.

DEPARTMENT OF RURAL SCHOOL EDUCATION

TEACHING

1. Two courses of instruction in School Gardening were given in the Department of Rural School Education during the past year. Owing to the increased work in extension, these courses have been discontinued until the academic side of rural school education shall be organized.

2. A course in elementary agriculture and nature-study was given in the Rural Schoolhouse during the six-weeks Summer School of 1912. The class met on Tuesday and Thursday afternoons, and various subjects outlined by the State Syllabus were presented by experts in the special fields. Forty-two persons registered for this work, and there were over fifty in attendance at each meeting. Special conferences were held for high school teachers and for rural leaders.

INVESTIGATION

Inasmuch as the extension work of the Department of Rural School Education is in touch with all the rural schools of the State, there is opportunity to follow up the work in particular schools showing features of special interest. It is very important that some investigation of actual school conditions, good and bad, in the rural districts of the State should be actively pursued. It is only in this way that the material sent out from the College in the interests of rural schools can be intelligently suited to the needs of those to whom it goes. Thus far there has been no provision for the maintenance of investigative activity in this Department.

EXTENSION

The aims of the extension work of the Department may be outlined as follows:

1. To furnish teachers with accurate subject-matter for instruction in agriculture.

2. To help direct the outlook of rural boys and girls in two ways: toward agricultural economy, which leads to prosperity; toward sympathy with their country life, which leads to happiness and contentment.

3. To correspond with persons in the State who are directing education, in order that the schools may be more easily reached and that we may know the present attitude toward our work.

4. To aid all supervisors of rural schools in their efforts to promote agricultural education.

5. To furnish the students in training schools and training classes with up-to-date subject-matter in agriculture. Many of the rural teachers of the future will be graduates of such schools.

6. To keep in touch with city superintendents.

7. To aid all teachers who desire to give instruction along some special lines of agriculture not outlined in the State Syllabus.

8. To interest all rural school children in Corn Day, now an established annual event in many schools. The purpose of this movement is to improve the corn crop of the State. Other crops will be considered later.

9. To aid leaders of agricultural contests by sending material on the organization and conduct of various kinds of contests; and to supply contestants with accurate technical subject-matter.

10. To encourage the children to write to the College letters relating to rural problems. This will interest them in a higher institution of learning and will teach them to consult persons trained along special lines in agriculture.

11. To furnish speakers on educational topics at meetings of teachers and grangers.

12. To know, through correspondence or personally, at least three spirited grangers in each county through whom any appeal for rural education can be made. These persons should receive all our publications, reports of work, and the like, and be called into council occasionally.

13. To reach, in as personal a way as possible, rural boys and girls between the ages of fourteen and twenty-two. Many of these young persons can be reached through the rural school teacher. We can now reach individually 7,800 boys and 10,000 girls between fourteen and twenty-two years of age; but our funds are not sufficient to prepare work for them or to conduct a correspondence with them.

14. To keep in touch with agricultural education in other States.

15. To keep in touch with literature on agricultural education.

16. To collect and exhibit in the Rural Schoolhouse at the College a representative school library and standard school equipment for agricultural instruction.

17. To cooperate in the movement for developing country-life recreation.

18. To further in every way possible the movement for the improvement of school buildings and grounds.

19. To be ready to promote any movement that seeks to redirect country life through the children of the State. Our connection with schools is such that in one mail we can send a message to 450,000 children in New York State.

Publications

The work of extension in rural school education is conducted mainly by means of the Cornell Rural School Leaflet. The first edition of the teachers' leaflet for September, 1911, comprised 30,000 copies, and a reprint of 5,000 copies was obtained in March, 1912. The leaflet comprised 172 pages and contained 134 illustrations. The figures showing the distribution of this leaflet up to May 1, 1912, are as follows:

To cities	10,165 copies
To villages	1,303
To training schools	146
To training classes	1,365
To teachers in rural schools	16,100
For all other purposes	1,700
	30,779 copies

At present there are less than 1,000 copies remaining, and these are being sent out to individual teachers on request.

In 1911–1912 the leaflets were issued as follows:

1. A November-December leaflet for children. Special effort in the interest of poultry was made in this leaflet, eleven practical poultry lessons being given. Lessons on birds, the weather, corn, corn foods, and Thoreau, and a letter to boys and girls, were included. The leaflet contained 24 pages and 19 illustrations. The edition of 75,000 was distributed to a corresponding number of children in rural schools.

2. A January-February leaflet for children. Special attention was given to school and home gardens in eight lessons in this leaflet. Notes, lessons on bird study, cleaning-up day, an apple tree, and the weather, and a letter to boys and girls, were also included. The leaflet contained 32 pages and 17 illustrations. This was also issued in an edition of 75,000.

3. An April-May leaflet for children. This leaflet contained lessons on bread-making, bird study, and growing corn; an article on "What I Expect of a Boy of Fourteen," by A. D. Dean of the State Education Department; a message to boys and girls from the editor; and a letter to boys and girls. A special feature was a supplementary colored picture of a red-winged blackbird. We hope to send one bird picture in color each year. The leaflet contained 12 pages and 7 illustrations. The edition was 100,000, of which 98,000 had been distributed before the schools closed.

4. The September, 1912, leaflet. Prior to October 1, 1912, the new teachers' leaflet for 1912–1913 had already been compiled and in large part distributed. It covers the nature-study and elementary-agriculture topics for study in rural schools during the coming year, as outlined by the State Syllabus. They are as follows: (1) For special bird study, the nuthatch and the hen; to be recognized, any two kinds of winter birds and any five of the following: oriole, goldfinch, phœbe, grackle, brown thrasher, meadow lark, cliff swallow, black-and-white warbler, peacock, eagle. (2) For special animal study, the cow and the cat; to be recognized, goat, fox, skunk, muskrat, frog. (3) For special plant study, the potato; to be recognized, one of the clovers, one of the grasses, one of the grains, and any six of the following: willow, cherry, daisy, marsh marigold, anemone, trillium, partridge berry, black medick, squash, turnip, pitcher plant. (4) For special insect study, the potato beetle and the lady beetle; to be recognized, tent caterpillar, honeybee, ant, hornet, spider. (5) For special tree study, the locust; to be recognized, two kinds of fruit trees, one conifer, and any four of the following: hemlock, spruce, cherry, quince, horse-chestnut, alder, elm, poplar, tamarack (larch).

The subjects given in the September Leaflet are as follows: The Point of View; Pedagogical Notes; Birdy Study; The White-breasted Nuthatch; The Economic Importance of the White-breasted Nuthatch; Birds to be Recognized; The Hen; eleven Poultry Lessons; Animal Study; four Lessons on Cows; Food; Animals to be Recognized; Insect Study; The Colorado Potato Beetle; The Lady Beetles; The Apple-tree Tent-caterpillar; Spiders; The Imported Cabbage Butterfly; The Cabbage Louse and Other Aphids; The Potato; How to Grow Potatoes; Potato-growing; Two Diseases of the Potato Plant and Their Control; When to Sell Potatoes; Growing Potatoes in the School Garden; Plant Study; Plants to be Recognized; Weeds; Some Common Weeds; Identification of One Grain, One Grass, One Clover; Tree Study (in four lessons); Two Fruit Trees; I Plow (poem); John Burroughs; Improvement of Rural School Buildings and Grounds; Suggestions for Teachers.

The leaflet comprises 186 pages, together with a colored frontispiece and an index, the whole bound in a heavy cover.

Up to October 1, 1912, 28,993 copies of this leaflet had been sent out, almost equaling the total distribution of the September, 1911, leaflet. The edition is 40,000, and before November 1 it is expected that every rural teacher and every city grade teacher in the State will possess a copy.

Correspondence

The correspondence connected with the extension work in Rural School Education is very heavy. For the year 1911–1912 more than 15,000 pieces of first-class mail were received, and about 3,000 typewritten letters sent out. In addition, more than 2,000 circular letters were sent out. All this is at present taken care of by one stenographer. Almost every letter coming to our office should receive a personal answer, but we have to neglect all except those requesting answers to some specific question.

Children's letters.— During the year 6,307 letters were received from boys and girls in the rural schools of the State. These were all carefully read, technical questions answered, and the letters recorded. When any child had written three letters a small gift picture was sent. One thousand and six children wrote the three letters and received the picture. We cannot encourage the correspondence with children in any personal way, for we could not take care of the letters. To do this work properly would require the entire time of a well-prepared person.

Meetings attended

Seven teachers' meetings were attended and addressed by Miss McCloskey and one by Mr. Tuttle during the year 1911–1912, with a total attendance of 2,000.

Farmers' Week

Headquarters for district superintendents and all persons interested in agricultural education were established at the Rural Schoolhouse on the campus during Farmers' Week in February, 1912. Meetings were held twice daily, at which professors, educators, and others gave addresses. Each session closed with an informal discussion. Over forty of the district superintendents were present for all or part of the week.

In addition to the educational meetings an exhibit of corn and of nature-study specimens, as mounted and preserved by rural schools, was received and set up. So much material came in that there was not sufficient space in which to display it.

Babcock test

The three four-bottle Bakcock-test outfits owned by the Department were put in circulation late in the year and one additional outfit was purchased. In all, seven schools received the use of an outfit for a month or more.

Building

It has been decided that the Rural Schoolhouse, which is the present headquarters of the Department of Rural School Education, shall be removed or torn down by April 1, 1913. Nothing could be more fitting than that this work should be centered in a modern rural schoolhouse of model design. Such a building serves as an object-lesson and an inspiration to those who visit it, in a way that could not be accomplished by any amount of printed propaganda. It should contain representative rural-school equipment, a well-selected library for teachers and pupils, and the like.

We cannot recommend too strongly that, in the event of the final disposition of the present building, either a new model schoolhouse shall be built or that this one be moved to a new location. In any case, provision should be made as soon as possible so that the work of the Department, continuous throughout the year, may not be seriously interrupted. Should it be determined to move the building now in use, it would be highly advisable to enlarge the cellar capacity for the purpose of storage facilities, to connect the toilets with a higher-pressure water system, and to remove the hot-air furnace and connect the building with the central heating plant. A new building should, of course, include the above features.

RECOMMENDATIONS

In general it may be said that there is evidence of a very decided growing interest in the teaching of elementary agriculture and nature-study in rural schools. On January 1, 1912, the 114 school commissioners of the State were superseded by 207 district superintendents for a term of five years. The extension work of this Department is meeting with enthusiastic commendation from teachers, district superintendents, city superintendents, members of the State Education Department of New York, and educators all over the country.

Maintenance

In the spring of 1912 a detailed estimate was made of the funds necessary for maintenance of the extension work of the Department of Rural School Education for the year 1912–1913. It included funds for the publication of the Cornell Rural School Leaflet monthly, for mailing envelopes, supplies, and stationery, extra clerical help, manuscript and drawings for the leaflet, children's pictures, traveling expenses, Farmers' Week, the loaning of Babcock-test outfits, additional office furniture, express, telephone, telegraph, printing, and livery expenses. The total amount needed, based on actual data, was $3,703.

The amount appropriated for the maintenance of this work for the year 1912–1913 is $1,500. In consequence, the scope of the work is much curtailed. We are obliged to issue four instead of nine leaflets, to cut out almost all traveling, and to limit all other items. It is most im-

Show at Chicago, immediately after Thanksgiving Day; to breeders and herds in the vicinity of Syracuse, immediately preceding the spring vacation; to the stockyards and slaughterhouses in Buffalo and to breeders in the vicinity sometime in May. These excursions are elective.

DAIRY INDUSTRY

1. **Milk Composition and Tests.** The topics considered are secretion and composition of milk, samples, lactometer, Babcock fat test, acid tests, moisture test, salt test, preservative tests.

2. **Butter-Making.** This course considers the principles and practice of butter-making in farm dairies and creameries, cream separation, pasteurization, starters, cream-ripening, churning, marketing, judging, etc.

3. **Cheese-Making.** In this course are considered the principles and practices of cheddar-cheese-making, apparatus and buildings, factory bookkeeping.

4. **Elementary Bacteriology.** The purpose of this course is to familiarize the student with laboratory methods, preparation of culture media, sterilization, methods of studying bacteria, and morphology and cultural characteristics of bacteria.

Dairy Mechanics. See Farm Mechanics 4.

6. **Market Milk and Milk Inspection.** Attention is given to the production and control of market milk, with special reference to its improvement; milk as food; shipping stations; transportation and sale; pasteurizing; standardizing; certified milk; milk laws; duties of milk inspectors; apparatus and buildings. The practice includes also visits to dairies in the vicinity of Ithaca. A two-day inspection trip in the neighboring counties may be arranged.

7. **Advanced Testing Laboratory Course.** This course includes work in such subjects as the determination of moisture and dry matter in dairy products, commercial tests for casein, various tests for butter fat, commercial tests for butter and oleomargarine, preservatives and adulterations, milk modification.

8. **Dairy Bacteriology.** This course deals with the sources of milk bacteria and methods of controlling their growth, bacteriological studies of market milk and other dairy products, different species of dairy bacteria, making of starters, effect of straining, separation, pasteurization and temperature, bacteriological methods of city milk inspection.

9. **Advanced Butter-Making.** The practice will consist of practical work in the creamery, where 600 to 1,000 pounds of butter are made daily. The work will include receiving and ripening cream, starter culture, manufacture of butter, testing for moisture and salt, and judging. Outside reading will be required.

10. **Fancy- Cheese- and Ice-Cream-Making.** The manufacture of certain brands of fancy cheese is given attention.

11. **Dairy Buildings and Equipment, and Business Methods.** This course will include location, plans, and construction of buildings suitable for creameries, cheese factories, and market milk plants; water supply and sewage disposal; equipment for special lines of dairy work; records; business management, including buying and selling of dairy products.

12. **Seminary.** This course is for advanced students and is required of graduate students taking work in the Department of Dairy Industry.

13. **Research.** Special problems in any line of dairy work can be taken up in this course according to the needs of the student. Facilities are provided for investigational work.

14. **General Agricultural Bacteriology.** The characteristics of bacteria, and the place of bacteria in nature; fermentations; bacteria in air, water, and sewage; the manure heap; soil bacteria; nitrogen fixation; relation of bacteria to the dairy and its products; the preservation of farm products, including fruits, vegetables, vinegar, silage, etc.

15. **Bacteriology for the Home.** This course considers the nature of bacteria and methods of studying them; the relation of bacteria to air and water, milk, and other foods; canning and preserving; molds and yeasts in their relation to household problems; decay of fruits; house sanitation.

16. **Milk Composition and Tests.** Similar to course 1; for special students only.

17. **Dairy Bacteriology.** Methods of studying bacteria, preparation of culture media, relation of bacteria to milk and other dairy products.

18. **Butter-Making.** For special students only.

19. **Advanced Cheddar-Cheese-Making.** This course considers some of the commercial and scientific problems of cheddar-cheese-making.

DRAWING

1. **Mechanical Drawing.** An elementary course to enable the student to make and read simple working drawings, plans, elevations, etc.

2. **Freehand Drawing.** An elementary course for the development of graphic expression applicable to scientific studies. Of special value to those who expect to enter teaching, nature-study, or biological research.

3. **Applied Drawing.** Personal instruction in problems of scientific drawing in pencil, pen and ink, wash, and water color.

7. **Freehand Sketching.** Sketching and rendering in various media of indoor and outdoor subjects particularly pertaining to landscape design.

ENTOMOLOGY, BIOLOGY, AND NATURE-STUDY

Biology

1. **General Biology.** This is an elementary course designed to acquaint the general student with the main ideas of biology through selected practical studies of the phenomena on which biological principles are based. Both lectures and laboratory work will deal with such topics as: the interdependence of organisms, the simpler organisms, organization and phylogeny, oogenesis and ontogeny, heredity and variation, natural selection and adaptation, segregation and mutation, the life cycle, metamorphosis and regeneration, and the responsive life of organisms.

Entomology

3. **General Entomology.** First term, lectures on the characteristics of orders, suborders, and the more important families, and on the habits of representative species. The practical exercises include a study of the structure of insects and practice in their classification. The lectures only (credit two hours) are taken by those who have had courses 4 and 5. Second term,

lectures on the more important insect pests and on methods of controlling them. The practical exercises will include a study of the different stages of as many of the forms as time will permit, together with observations in the field on the habits of the pests

4. **Elementary Morphology of Insects.** An introductory laboratory course required of all students who plan to do advanced work in the Department of Entomology.

5. **Elementary Systematic Entomology.** A study of the wing venation of insects and the identification of specimens belonging to the more important orders and families. With course 4, required of all students who plan to do advanced work in the Department of Entomology.

6. **Advanced Systematic Entomology.** A training course in the identification and interpretation of obscure characteristics used in the classification of insects.

7. **Histology of Insects.** A laboratory course to accompany or follow the first term of course 12.

9. **Advanced Economic Entomology and Insectary Methods.** Economic problems connected with applied entomology, discussed, reported upon, and field observations made. Experimental methods in breeding, photographing, investigating, and controlling insects discussed and studied. Designed for advanced students in entomology who desire to fit themselves for experiment station work.

10. **Classification of the Coccidae.** Designed to familiarize the student with the more injurious species of scale insects, the methods of preparing specimens for study, and the systematic arrangement of the species.

12. **Morphology and Development of Insects.** Laboratory work to accompany or to follow this course is offered under course 7.

14. **German Entomological Reading.** Open only to advanced students in entomology or zoology.

16. **Elementary Economic Entomology.** A course designed for special students; not open to regular students. Discussion of insect pests in general, with remedial suggestions. Occasionally, the class will be taken to the field to observe insect pests at work.

17. **Literature of Systematic Entomology.** A systematic study of bibliographies, indexes, and general entomological literature; the preparation of catalogs of insects; the evolution of the rules of zoological nomenclature; and the methods of determining the priority of generic and specific names.

19. **General Limnology.** An introduction to the study of the life of inland waters. Aquatic organisms in their qualitative, quantitative, seasonal, and ecological relations.

20. **Research in Limnology.** Laboratory and field work.

22. **Animal Parasites and Parasitism.** A consideration of the origin and biological significance of parasitism, and of the structure, life history, and economic relations of representative animal parasites.

23. **The Relations of Insects to Disease.** Causation and transmission of disease by insects and other arthropods.

24. **The Classification of Immature Insects.** The taxonomy of nymphs, larvæ, and pupæ.

27. **Research in Morphology of Insects.** Special work arranged with reference to the needs and attainments of each student.

28. **Research in Systematic Entomology.** Special work arranged with reference to the needs and attainments of each student.

29. **Research in Economic Entomology.** In most cases it is impracticable to complete an investigation in this subject during the college year. Students must arrange to conduct their observations during the growing season.

30. **Aquiculture.** A course on the utilization of the resources of our inland waters.

Seminary. The work of an entomological seminary is conducted by the Jugatae, an entomological club which meets for the discussion of current literature and of the results of investigations. Attendance at the meetings may be counted as laboratory work.

EXTENSION TEACHING

1. **Extension Work.** Lectures and discussions on problems of university extension in agriculture. Practice in oral and written presentation of topics in agriculture, with criticism and individual appointments on the technique of public speech. Designed to acquaint students with parliamentary practice, to encourage interest in public affairs, and to train for effective self-expression in public. A few juniors and seniors will be sent out into the State to address meetings.

2. **Extension Work.** A continuation of course 1. Special training will be given to competitors for the Eastman Prize for public speaking.

FARM MANAGEMENT

1. **Farm Management.** Lectures, recitations, and laboratory practice on farm accounting, farming as a business, regions and types of farming, forms of tenure, selection and purchase of a farm, capital and its distribution, the farm layout and building arrangement, cropping systems, the management of manure and fertilizers, the efficient use of labor and machinery and horses, marketing of farm products, studies of the management of successful farms, preparation of plans for the organization and management of specific farms. Two one-day excursions will be held about May 10 and 20 to farms at some distance from Ithaca.

2. **Regions and Systems of Farming.** The work in this course will be done just before the opening of the fall term. The class will travel in New York, Pennsylvania, and New Jersey, for about eight days. Students may join the class at points most convenient for them. It is recommended that they arrange to visit regions with which they are not familiar. Only those who satisfactorily complete five days of work will receive credit. The days will be spent in studying the methods of farm management on successful farms, and the evenings in discussions and writing of reports. A full written report will be required.

3. **Advanced Farm Management.** A further study of farm management, including lectures, problems, reading, and trips to successful farms.

4. **Research.** Investigation of special problems in farm management.

5. **Seminary.** Open to graduate students and a limited number of undergraduates who are taking course 3 or 4.

FARM MECHANICS

3. **Farm Mechanics.** A study of the principles of operation, the details of construction, and the practical operation and care of: A — Machinery, including gasoline engines, water wheels, devices for transmitting power, farm lighting systems, hydraulic rams, pumps, spray nozzles, spraying outfits, water-supply outfits, plain soldering, and simple pipe-fitting for water. B — Implements for tillage, seeding, and harvesting, with a discussion of the special mechanical features of some implements now on the market.

4. **Dairy Mechanics.** A brief lecture course on the principles of operation, installation, and care of steam boilers, steam engines, and piping for steam.

S4. **Forge Work.** A course given in Sibley College especially for agricultural students, covering the construction of the forge, selection of coal, care of the fire, practice in forging to shape and size, welding iron and steel, and tempering steel. By paying for material used, the student will have opportunity as far as time permits to make for himself a set of tongs, punches, chisels, and other tools.

19. **Research in Farm Mechanics.** Special work in farm mechanics on problems under investigation by the Department or of special interest to the student, provided, in the latter case, the Department can furnish adequate facilities.

20. **Farm Engineering.** A study of the practical solution of the problems involved in connection with surveying and mapping the farm; locating, digging, and laying drains; laying out building foundations; farm water-supply and sewage disposal; road construction and maintenance, with a discussion of the New York State Highway Law. From data obtained in the field a drainage map will be drawn for one of the fields near the college.

28. **Advanced Work in Farm Engineering.** A course intended to provide opportunity for students to conduct special problems on their home farms, or on selected farms in connection with advanced problems in other departments, provided the farm is so situated that the work can be properly supervised.

FARM PRACTICE AND FARM CROPS

Farm Practice

1. **Farm Practice.** An elective course designed to assist students in meeting the requirements of farm practice demanded by the College.

Farm Crops

1. **Cereals, Forage Crops, Potatoes, and Miscellaneous Crops.** Lectures, recitations, and laboratory practice on the history, production, and marketing of cereals, potatoes, field beans, forage crops, and miscellaneous crops.

5. **Research.** Investigation of special farm crops subjects. Also a study of current experiment station literature.

6. **Seminary.** Required of all students engaged in research in farm crops; not open to others.

FORESTRY

1. **Farm Forestry.** The management of the farm woodlot, and the starting of new woodlots by planting or sowing. A course dealing with the woodlot as deserving and repaying proper care such as is given the other crops on the farm.

2. **Silviculture.** Designed for students who wish a more detailed course dealing with the raising of timber. The topics will include: forest description; the life history of the tree and of the forest; the influence of soil, climate, and other factors on the forest; the influence exerted by the forest on climate, soil, and stream flow; forest planting and sowing and forest nursery work; natural reproduction of the forest (that is, reproducing the forest without planting or sowing); care of the crop during its growth, including thinning; protection from fire and other enemies.

HOME ECONOMICS

A four-years course in home economics is planned for students desiring to specialize in this work. The first two years of the course follow the work as outlined for all students in the College of Agriculture, with the addition of some courses not required in the regular schedule. The last two years permit specialization in some one or more of the branches included under the term home economics. As the course develops, new subjects will be incorporated. All students who register in this Department must report to the Department at the beginning of the freshman year.

1. **Survey Course in Home Economics.** A nonprofessional course intended for students registered in any department in the University who desire a general knowledge of some of the subjects grouped under the term home economics. The lectures will include a discussion of foods, food preparation, human nutrition, household sanitation, household management, and house planning.

2. **Field of Home Economics.** A course to establish in the mind of the student the relation of home economics to the sciences and arts; its significance in home-making, professional life, and technical lines of activity.

3. **Foods.** A course for establishing a fundamental knowledge of foods. The lectures will include a discussion of the composition and characteristics of foodstuffs; principles of selecting foods and methods of preparing them, food preservation and adulteration, comparative nutritive and economic values of various food combinations. Laboratory practice will be given to apply scientific principles to food preparation.

4. **House Sanitation.** The lectures in this course will include consideration of the sanitary conditions of the house and site; conditions for health and care of sick; the relation of bacteriology to the household in cleaning, in the preservation of foods, in disease, and in disinfection.

5. **Institutional Management.** This course is for students in home economics who wish to choose a field, outside of teaching, in caring for and feeding large numbers. The laboratory will be Sage College, a cafeteria, a tea room, etc.

6. **Human Nutrition.** A course for the development of a working knowledge of human nutrition. A study of methods of investigating dietary problems and of the practical means of applying scientific principles in planning family and institution dietaries; consideration of special problems of nutrition, as in infant feeding and feeding in cases of abnormal metabolism. Laboratory work will include, as far as possible, practice in planning and preparing dietaries. An excursion of three or four days to visit schools and various industries will occur at the close of the spring vacation.

9. **House Planning.** An elementary course for developing economic house plans in accordance with architectural principles. Besides the drawing of plans, the course will include discussions of the building site, building materials, elements of construction, laying out the grounds, and criticisms of interior design.

10. **Household Art.** A course for the development of artistic expression in the individual. The lectures in this course will apply principles of color and design to questions of interior decorating and furnishing. Students will experiment with color combinations for decorative schemes, and with textile combinations for curtain stuffs, wearing apparel, etc.

12. **Woman and the Family.** This course embraces a study of woman and the family through the early ages to the present time. It treats survivals with reference to various characteristics and conditions of woman in the family and in the state. Woman's work and her industrial and economic condition from the beginning are studied with reference to present conditions and their effect on society.

14. **Household Management.** This course will include a study of the family income, cost of living, household accounts, problems of domestic service, methods of housekeeping, equipment, marketing; housekeeping for large numbers.

20. **Special Problems.** A course intended for the development of the individual student in particular lines of work. Special facilities will be arranged for those intending to teach home economics, which will include a consideration of the logical methods of organizing and developing courses of study in home economics. Problems of original investigation will be planned for graduate students, or for undergraduate students who have proved themselves capable of undertaking such work.

22. **Seminary.** Required of students in home economics and open only to them.

HORTICULTURE

Floriculture

15. **Commercial Floriculture.** The culture, diseases, botany, and history of florists' plants, and methods of greenhouse management. Practice in the greenhouses. Those desiring more work in the greenhouse can arrange for one or two additional periods, with credit.

16. **Florists' Plants and Garden Flowers.** A continuation of course 15, with outdoor gardening in the spring.

19. **Greenhouse Construction.** The development of the modern greenhouse; types of houses, materials, and methods of construction, installation of heating systems, etc. Laboratory practice in erecting section of cypress and iron frame houses, and in planning and estimating the cost of commercial ranges. The class will participate in a required excursion to Elmira on December 9.

21. **Investigation in Floriculture.** The investigation of problems in the growing of cut flowers, exotics, and garden flowers; hybridizing; study of varieties.

22. **Greenhouse and Garden Practice.** Designed for those who desire to enlarge their knowledge of greenhouse and garden plants and their culture.

Olericulture

25. **Elementary Vegetable-Growing.** The principles of vegetable-growing as applied in commercial and home production. Important vegetable crops — their adaptation, culture, special requirements, varieties, enemies, marketing, and profits. The laboratory work includes exercises in management and planning, the growing of early plants under glass, and the planting and care of early outdoor vegetables. Each student assumes charge of his own plantings, carrying them through to the end of the term.

26. **Vegetable-Forcing.** Vegetable-growing under glass. Important forcing crops. Laboratory will consist of practical work in crop production. Each student will be assigned a plot in the greenhouse on which he will grow vegetables to maturity, assuming full charge except in heating and ventilation. This will be supplemented by descriptive studies.

27. **Systematic Olericulture.** Lectures and descriptive studies dealing with vegetable crops, their origin and botany. Special attention will be given to varieties, and their adaptation to different cultural and market conditions. The important commercial types of the different vegetables are grown in the garden each year and there is an abundance of first-hand material for the course.

28. **Advanced Oericulture.** The student's time will be divided between advanced systematic and cultural studies of vegetable crops, and the study of a special problem to be agreed upon. An excursion to two or three important vegetable-growing centers will constitute a part of this course, the cost being eight to ten dollars; date to be announced later. Work and exercises in the planning and management of greenhouse establishments.

Advanced and Special Courses

32. **Elementary Horticulture.** This course aims to emphasize principles and practices involved in the cultivation of garden plants grown for pleasure or profit. It includes the propagation, botany, culture, and economic uses of plants. Some attention is also given to garden-making. Designed for teachers of nature-study or of elementary agriculture.

33. **Nuciculture.** Lectures on the practical and systematic phases of nut culture, with special reference to the cultivation and improvement of the forms native to the United States. The Morris collection of edible nuts of the world in the Department of Horticulture furnishes abundant material for illustrating the lectures. The Robert T. Morris prize of twenty-five dollars for proficiency in propagating nut trees is offered in this course.

34. **Subtropical Pomology.** A study of citrus and other tropical fruits, with special reference to American conditions. Copiously illustrated. Laboratory work in describing and judging the various fruits.

35. **Literature of Horticulture and Landscape Gardening.** A comprehensive survey of the writings of European and American authors, with special reference to the evolution of horticultural methods.

36. **Evolution of Plants.** Historical development of theories of evolution; recent theories, including a careful examination of present-day methods. Practice in the greenhouse in the technique of plant-breeding.

37. **Investigation.** The student is assigned a subject which, as far as possible, combines original research with bibliographical methods.

38. **Seminary.** Required of advanced students who elect Horticulture 37, and of all graduate students.

METEOROLOGY

1. **Meteorology and Climatology.** Lectures and weather observations. Designed to acquaint the student with the general circulation of the atmosphere; development, movement, and conditions that attend cyclones, tornadoes, and special storms; practical weather forecasting from weather maps and local observations; the use of meteorological instruments; general and special climatology and its relation to agriculture.

PLANT-BREEDING

1. **General Plant-Breeding.** A study of the elements of plant-breeding, including variation, selection, and hybridization. The laboratory exercises are designed to give practice in measuring variation, making hybrids, and planning plant-breeding schemes adaptable to farm practice.

2. **Plant-Breeding.** This course will undertake a careful consideration of the principles and practice of plant-breeding with reference to variation, selection, and hybridization as factors in the amelioration of cultivated plants. Special consideration will be given to the methods and results of present-day plant-breeders.

3. **Plant-Breeding.** A continuation of course 2.

4. **Biometry.** A discussion of statistical methods as applied to problems in biology and practical breeding. The course is designed primarily to develop methods which may be used by graduate students in conducting their investigations.

5. **Research.** This course affords the student an opportunity to study a plant-breeding problem which will give him practice in bibliographical and research methods.

6. **Research.** Problems in plant-breeding, heredity, and general evolution.

7. **General Seminary.** A seminary for the discussion of the fundamental problems of plant-breeding, heredity, and general evolution, of methods of plant-breeding, and of plant-breeding literature.

8. **Advanced Seminary.** A seminary for the discussion of the fundamental problems of variation, heredity, and evolution.

PLANT PATHOLOGY

1. **Plant Pathology.** A fundamental course treating of the common diseases of cultivated plants, their nature, cause, and control. A prerequisite for all other courses in plant pathology.

2. **Principles of the Control of Plant Diseases.** A consideration of methods for the control of plant diseases, including sanitation, seed treatment, seed selection, spraying, tree surgery immunization, preservation of timber, etc.

3. **Laboratory Methods in Plant Pathology.** Required of all students taking advanced work.

4. **Etiology of Plant Diseases.** Designed especially for students who wish to specialize in plant pathology. The taxonomy and phylogeny of organisms producing diseases in plants.

6. **Diseases of Fruit and Fruit Trees.** Designed especially for students who expect to become practical fruit-growers.

Advanced and Graduate Courses

14. **Phytopathological Technique.** Laboratory practice in the study of the pathogenicity of organisms, isolation, culture work, inoculation, infection, etc.

15. **Phytopathological Histology.** Study of types of histological modifications of plant tissues resulting from disease.

20. **Research.** Original investigation of problems in plant pathology.

25. **Seminary.** The work of the seminary in plant pathology is conducted by the Plant Doctors, a phytopathologists' club which meets for the discussion of current literature and of research.

PLANT PHYSIOLOGY

3. **Crop Ecology and Geography.** Lectures, demonstrations, laboratory exercises, and reports, emphasizing the relations of plants to climate; a study of crops and economic plants with respect to environment and distribution.

7. **General Plant Physiology.** Lectures and laboratory work, supplemented by field studies where possible. The topics include absorption, nutrition, relations to environment, growth, reproduction, and propagative processes. Limited as to number in 1911–1912 unless additional space is provided.

8. **Advanced Plant Physiology.** Lectures, laboratory practice, and reports. This is a comprehensive course in normal physiology and requires on the part of the student good fundamental preparation. It is designed for those specializing in plant study.

9. **The Physiology of Fermentation.** Recommended for graduates and for undergraduates specializing in physiological, bacteriological, or pathological work.

12. **Cytology.** A course for advanced students, giving instruction in the physiology of the cell, and of reproduction and inheritance. Microtechnique and special topics.

Courses Primarily for Graduates

14. **Special Chapter in Metabolism.** A study of some of the more important temporary and storage products of plant metabolism.

16. **General Seminary.** During the first term, topics will be chosen from current work in plant physiology. During the second term, special outlines will be followed and reports in research presented.

17. **Seminary in Cytology.**

18. **Research, General Physiology.**

19. **Research, Cell Physiology.**

In courses 18 and 19, problems in plant physiology (including ecology, cytology, and heredity) and the general relation of plant physiology to agriculture will be assigned for investigation. Reports or theses will be required.

POMOLOGY

1. **Elementary Pomology.** A study of the methods of propagation and early care of commercial fruits; the principles of budding, grafting, pruning, and planting. A part of the work in the study of varieties and the practice of packing apples is included.

2. **Practical Pomology.** A study of the soils, varieties, and planting plans for the orchard; cultivation, cover crops, fertilization, spraying, and pruning as practiced in orchard management; the picking, grading, packing, storing, and marketing of fruit. This course considers the apple, pear, quince, cherry, plum, apricot, peach; and the nuts.

4. **Bush Fruits.** A lecture course which considers the grape, raspberry, blackberry, dewberry, currant, gooseberry, and strawberry. The topics discussed are: varieties, planting, culture, picking, grading, packing, and marketing.

6. **Spraying of Fruit Trees.** A study of the preparation and application of the spray mixtures used in orchard practice.

8. **Advanced Practical Pomology.** The course considers the packing of apples in boxes and barrels; a comprehensive study of the varieties of peaches, plums, grapes, pears, and apples; the judging of fruits. From the students in this course teams will be chosen to do practical judging at the annual meetings of the state societies at Rochester. The preparation of the fruit exhibit at the College is required of the students in this course.

10. **Systematic Pomology.** A course designed primarily for graduates and students who are preparing to do experimental work. A study of the characters and botanical relationships of the fruits of the United States. Each student is required to collect and mount a number of varieties and species.

13. **Research in Pomology.** Original investigation of problems in pomology. A typewritten thesis is required.

14. **Seminary.** Open only to graduates and students taking course 10 or 13.

POULTRY HUSBANDRY

1. **Poultry Husbandry.** A general elementary discussion: kinds of poultry farming; principles of poultry-house construction; breeds of domestic poultry; principles of poultry-breeding; anatomy of poultry; the killing, picking, grading, and packing of poultry; caponizing; poultry diseases and parasites; poultry feeds; feeding for egg-production; fattening and rearing; marketing poultry products; judging of dressed poultry and eggs; incubating and brooding. There will be short excursions to poultry farms, Saturday, May 11, and Saturday, May 18 (not required).

2. **Feeding and Management.** The managing and keeping of records of a flock of fowls for egg-production and for fattening, including the care and sale of eggs.

3. **Incubator Practice.** Practice in operating incubators and in keeping records, including the taking apart and setting up of machines, etc.

4. **Advanced Judging.** The origin, history, and classification of breeds of domestic poultry. Judging the principal breeds for fancy points, by both score-card and comparison methods.

5. **Poultry-Farm Management.** There will be several excursions to representative poultry plants in April and May.

8. **Research.** The conducting of an original investigation of a problem in poultry husbandry, to be presented as a written thesis.

9. **Seminary.** For advanced study and conference. Includes review of literature, written reports on research, and study of advanced problems.

RURAL ECONOMY

1. **Agriculture.** A brief general survey of agriculture in its technical, economic, social, and historical aspects. Designed to give the beginner a view of the whole field of agriculture.

4. **Rural Economy.** A study of the general economic problems of agriculture.

5. **Rural Social Conditions.** A study of the social history, status, and problems of the rural community.

6. **History of Agriculture.** The more important phases of the development of agriculture are considered historically.

7. **Conservation.** Open to juniors and seniors in all colleges.

8. **Cooperation.** A study of the general principles and history of cooperation with special reference to agriculture and the conditions prevailing in the United States.

14. **Rural Economy.** An advanced course of more detailed and critical study of a few of the general economic problems of agriculture.

18. **Investigation.** For graduates not candidates for degrees and for advanced seniors by special permission.

19. **Seminary.** Devoted to current literature, the study of monographs, and reports on the progress of the investigations by members of the seminary.

RURAL EDUCATION

It is expected that courses in rural education, for the benefit of those who expect to teach, will be offered in 1911–1912.

SOIL TECHNOLOGY

1. **Principles of Soil Management.** An elementary course covering the derivation, classification, function, and properties of soils, and the principles of their management in plant production.

2. **Principles of Soil Management.** Should be taken the first year. Similar to course 1.

6. **Advanced Soils.** Discussion of the physical, chemical, and biological properties of the soil as they bear on crop production; mechanical analysis; physics of the retention and movement of moisture and air; absorption of heat; chemistry of soil solution; alkali and its amelioration; the biological relations of the soil as they affect fertility.

7. **Manures and Fertilizers.** This course deals with the kinds, quality, composition, deterioration, and economic use of manures; the sources, function, composition, and use of commercial fertilizers; the kinds, use, and efficiency of amendments.

8. **Drainage and Irrigation.** History, economic relations, principles, and practice of drainage and irrigation.

10. **Advanced Laboratory.** A series of experiments illustrating the physical and chemical properties of soil in their relation to moisture, fertilization, and plant production.

11. **Research in Soils.** Three graduate students who are qualified to conduct research in certain phases of soil investigation may register for major subject in the research laboratory.

14. **Soil Seminary.** Review of current literature, preparation of special reports, and the discussion of current problems in soil management.

RURAL ART

Not Open to Special Students

1. **Rural Improvement.** This course consists of brief outlines and discussion of the ways and means of bettering out-of-door conditions. It deals with questions of rural improvement, such as will enable the young man or woman from the farm, or others, to get a point of view in rural art in general, together with specific hints for working out some of his home problems.

2. **Lectures Introductory to Work in Rural Art.** Intended for freshmen and sophomores.

3. **History of Landscape Design.** A study of the chronological development of the art of landscape gardening, its modifications in various countries, and the influences which have affected it. A full study of the three types of gardening, ancient, medieval, and modern, and their relation to landscape work of the present day.

4. **Theory and Æsthetics of Rural Art and Landscape Design.** A study of the principles of landscape design, and discussion of theory in application to specific problems. Professor FLEMING and Assistant Professor DAVIS will be assisted by representative farm superintendents, nurserymen, park superintendents, gardeners, garden architects, civic advisers, and landscape architects. Subjects to be covered are as follows: Ideals of landscape design; the appreciation of landscape; the personal equation in landscape design; principles, elements, and materials of landscape design; landscape improvement of farms; private properties; country estates; home grounds; gardens; public properties; civic design; park planting; park maintenance.

5. **Landscape Design.** Work on practical office and local problems in design, finished plans, and detailed working drawings, with specifications. The aim is to familiarize the student with the various types of plans and presentations as applied to different problems. A series of competitive sketch, preliminary, and final problems continues throughout the year. These will be judged by a competent committee.

6. **Organography of Plant Materials of Landscape Gardening.** A comprehensive study of the ready identification at all seasons of trees, shrubs, vines, and perennials (native and introduced) which are used by the landscape gardener. This course is not distinctively horticultural, but is designed to familiarize the student in landscape design with the planting material used in general landscape work. Special attention is given to the general characteristics of such material, considered as elements of composition in outdoor art.

7. **Freehand Sketching.** Sketching and rendering in various media of indoor and outdoor subjects pertaining particularly to landscape design and its presentation.

8. **Advanced Problems and Research in Landscape Design.** The more complicated problems, such as country estates, parkways, and civic centers, are worked out in detail. Studies, reports, plans of arrangement, rendered studies, detailed drawings, grade designs, planting plans, total estimates of cost, and a set of specifications, are worked out for two major problems. Minor problems are required from time to time.

9. **Landscape Engineering and Details of Construction.** The engineering work peculiarly necessary to landscape gardening will be considered, such

as the making of models, relief maps, contour maps, setting of grade stakes, slope stakes, making profiles, sections, and finished grade designs, use of plane table, estimates of cost of construction.

10. **Plant Materials of Landscape Gardening.** A detailed study of the use, adaptation, arrangement, and æsthetic composition of ornamental trees, shrubs, vines, and perennials in all the phases of landscape gardening; planting problems of the landscape architect, park commissioner, and landscape gardener; planting plans, nursery lists, and estimates of cost of planting.

11. **Seminary.** This course includes review of current literature, the discussion of important questions relating to various phases of landscape work, and reports on investigations.

Excursions. During or at the end of the second term, a four- or five-day trip is generally taken for the purpose of studying good examples of landscape work.

NORMAL DEPARTMENT — NATURE-STUDY

1. **Nature-Study Pedagogy and Literature.** Lectures on nature-study as a part of primary education and a discussion of methods of correlating nature study with other school work; a review of popular nature literature and its effect on the child.

2. **Nature-Study in Field and Laboratory.** This course gives laboratory and field practice with those subjects in plant and animal life which are best fitted for nature-study in the elementary schools. Special attention is given to methods of study and manner of presentation, and also to the relating of the topics to agriculture. The work consists of conferences, and field and laboratory practice.

3. **Nature-Study. Advanced Course.** Field and laboratory work. This course includes the nature-study of the garden.

4. **The Nature-Study of the Farm.** This course deals, from the standpoint of nature-study, with the common birds, animals, insects, trees, plants, and weeds found most commonly on the farm and of special interest to the farmer. Discussion of popular nature literature. This is especially planned for students from the farm and those interested in introducing nature-study into the rural schools.

5. **Nature-Study Seminary.** Informal discussions of the relations of nature-study to life, to science, to agriculture, and to the public schools.

6. **School Gardening.** Lectures on gardening as related to education; management of school gardens; discussions relating to school gardens.

WINTER-COURSES

I. GENERAL AGRICULTURE

Required Subjects

All students in the Winter-Course in General Agriculture are required to take four of the following five subjects:

1. **Fertility of the Land.** A study of soils from the chemical and the physical point of view, with discussions of fertilizers, manures, and the principles of plant growth.

2. **Agronomy.** A study of field crops and farm management. As much time as possible is devoted to the principles of soil management and the culture of particular crops, as corn, potatoes, wheat, and oats, and to pastures and forage.

3. **Feeds and Feeding.** The principles and practice of compounding rations and of feeding farm animals.

4. **Breeds and Breeding.** The principles of breeding farm animals; the history of breeds; the adaptation of different breeds for certain purposes; the care of farm animals.

5. **Horticulture.** The principles of fruit-growing, vegetable-gardening, and floriculture; the propagation of fruits, budding, and grafting; orchard tillage, fertilizers, pruning, and spraying; the harvesting, marketing, and storing of fruit. The planning and planting of the vegetable garden; fertilizers, tillage, and control of pests and diseases. Lectures covering the growing and marketing of flowers.

A series of special lectures will be given by various members of the university faculty, and by prominent men from elsewhere who are authorities in agriculture and horticulture. Students in the course in General Agriculture are required to attend these lectures.

Elective Subjects

60. **Commercial Fruit-Growing.** For description of this course see p. 30.

61. **Vegetable Culture.** A study of the growing and marketing of vegetables for home use and for the special and general market.

6. **Rural Improvement.** A course of six lectures, commencing after the Christmas recess, dealing with questions of rural improvement and intended to give the farm boy a general view of rural art together with specific hints for working out some of his home problems.

7. **Farm Mechanics.** A study of gasoline and steam engines, power transmission and shafting, pumps, hydraulic rams, piping, and soldering.

8. **Farm Dairying.** The care of milk, butter-making, and milk-testing.

3 and 4. **Animal Husbandry.** The student who desires as much work as possible in animal husbandry may take both 3 and 4 in that subject, as described on p. 13.

9. **Farm Poultry.** A discussion of the domestic breeds of poultry; hatching and rearing; the principles of feeding and management; the building of poultry structures.

10. **Economic Entomology.** A study of insect pests of farm, orchard, and garden, and of their control.

11. **Plant Diseases.** This course is devoted to the consideration of some of the common bacterial and fungous diseases of plants. It includes a study of the causal organisms, their relation to the host plants, and their control.

12. **Diseases of Dairy Cattle, and Veterinary Hygiene.** For description of this course see p. 22.

13. **Farm Structures.** A discussion of the principles involved in the construction of farm barns, stables, silos, and other buildings; fencing, farm road-making, and the use of concrete on the farm.

14. **Extension Work.** A study of the problems of university extension in agriculture. Practice in the oral and written presentation of topics in agriculture, with criticism and individual conferences on the technique of public speech. Designed to acquaint students with parliamentary practice, to encourage interest in public affairs, and to train for effective self-expression in public.

15. **Plant-Breeding.** A discussion of plant improvement with special reference to farm and horticultural crops. Methods of selection and hybridization as means of improvement will be carefully considered.

16. **Farm Forestry.** A course of six lectures discussing the care of the woodlot, forest planting and sowing, the cutting of timber, and the protection of the woodlot.

II. DAIRY INDUSTRY

Lectures and Recitations

20. **Milk and its Products.** This course includes a full description of the secretion or formation of milk, its nature and composition, the methods of testing it, its care and preservation, the manufacture of different dairy products, conditions affecting their quality, method of marketing, the business side of dairying, the construction of dairy buildings, and the legal requirements applying to dairy products. Special attention is given to dairy bacteriology and dairy sanitation. The lectures are supplemented by references to dairy literature, books, current periodicals, and experiment station publications.

3. **Animal Husbandry, Feeds and Feeding.** This course deals with the principles and practice of compounding and feeding the most economical rations.

21. **Dairy Mechanics.** The care of the boiler and engine, construction of separators, installation of shafts and pulleys, pipe-fitting, belt-lacing, soldering, etc.

22. **Dairy Chemistry.** The elementary principles of chemistry are explained, that the student may better understand the composition of dairy products and the chemical changes connected with and influencing dairy operations.

23. **General Agriculture.** In this course several brief lectures are given on subjects intimately related with dairy industry, such as farm manures, commercial fertilizers, and the improvement of the land by judicious cropping.

12. **Diseases of Dairy Cattle, and Veterinary Hygiene.** This course includes a discussion of the most common diseases of dairy cattle, their prevention and cure, the ventilation of stables, and general questions of animal hygiene.

Practice

30. **Butter.** The creamery has most of the apparatus found in a well-equipped commercial plant. The milk is received, weighed, sampled, and separated, and the entire process of ripening cream and churning carried through in the most thorough manner. Special attention is given to pasteurization and the use of starters. Every step of the work is performed by students under the close supervision of the instructor.

31. **Cheese.** The cheese room is equipped with all necessary apparatus, such as is used in large factories for making cheddar cheese. All the work is performed by students and every step is carefully observed and reported by them on blank forms provided for the purpose. Special attention is given to judging the quality of milk for making cheese and to judging the cheese when ready for market.

32. **Fancy Cheese.** A study of a few varieties of fancy cheese.

33. **Market Milk.** The market-milk rooms are equipped with apparatus such as is found in commercial plants. Students are given practice in preparing and bottling milk and cream for retail trade. Quick and accurate methods of standardizing milk and cream are taught.

34. **Testing.** The testing laboratory is fitted with all appliances necessary for making the usual quick tests of milk and its products, including lactometers and a variety of Babcock testers. Each student is expected to become familiar with the Babcock method of determining fat, the calculation of total solids, and the more simple tests for preservatives and adulterations.

35. **Dairy Mechanics.** The student has an opportunity to learn the construction of the boiler and engine, to care for them, to take separators entirely apart and to set them up again, to repair pipes, to solder, to lace belts, etc.

36. **Arithmetic and Bookkeeping.** A thorough drill is provided in simple problems, such as are constantly arising in all kinds of dairy work, and in the keeping of factory accounts.

37. **Dairy Bacteriology.** Elementary laboratory work will be given to show the nature of bacteria and their relation to the handling of milk and dairy products.

III. POULTRY HUSBANDRY

37. **General Poultry Lectures.** These lectures include discussions of subjects of special interest to poultrymen: opportunities in poultry husbandry; advantages and disadvantages of various kinds of poultry-keeping; laying out and estimating the cost of poultry plants; poultry-farm management; history and characteristics of breeds; feeding for egg-production and for flesh; incubating; brooding; feeding chickens; caponizing; mating and breeding; marketing poultry products; planning and building poultry houses.

37a and b. **Special Resident and Nonresident Lecturers.** The Poultry Department is fortunate in being able, through the courtesy of the Cornell Medical College and the New York State Veterinary College, to avail itself of the expert services of several eminent teachers. Their lectures, together with those of several other experts from other departments in the College of Agriculture and of experienced poultrymen who have had marked success in some special line of poultry husbandry, furnish a course of one lecture a week during the entire term.

38. **Laboratory Practice.** This course consists in planning and studying poultry buildings and colony houses; laying out poultry plants; making egg crates, shipping coops, and trap nests; selecting fowls for mating; killing, dressing, packing, and marketing poultry; caponizing; study of the egg; anatomy of poultry; study of poultry feeds; fitting fowls for exhibition.

39. **Feeding and Management Practice.** A flock of 25 or 30 fowls is assigned to each student, who performs all of the daily operations in caring for it, keeping accurate accounts of the cost of food, gain or loss in weight, temperature of houses, time required to do the work, and the profit or loss. Practice is also given in crate fattening. In addition to this, the student takes his turn in doing all of the different kinds of work about the poultry plant, including the handling of gasoline engines, power bone-cutters, and cleaning.

40. **Incubator and Brooder Practice.** The student operates an incubator and gives a complete record of his work and of the results. At the conclusion of each hatch, the results of the hatch from each of the incubators are tabulated so that the various machines can be compared, and the fertility, the hatching power of the eggs, and the vigor of the chicks from the different pens, can be observed.

The season of the year and our lack of facilities make it impracticable to give systematic practice in brooding chickens. Whenever the student cannot be assigned a brooder with chickens, demonstration work is given. The brooder work includes the operation of the New York State gasoline-heated colony house, where 200 to 300 chickens are kept in one flock; also a pipe-system brooder house and several types of outdoor brooders.

42. **Systematic Reading.** This reading is intended to supplement the lectures. One forenoon each week is set apart in which the students can devote themselves to special reading along the lines in which they are interested.

43. **Drawing.** Drawing plans of poultry houses, incubators, and brooders.

IV. HORTICULTURE

I. FRUIT-GROWING

All students in this course, except those who have already satisfactorily completed the Winter-Course in General Agriculture, are required to take the subjects that follow. Those who have completed the Winter-Course in General Agriculture will not be required to take again subjects in which they have already passed. They should consult the professor in charge concerning substitutes for any of the subjects.

Required Subjects

60. **Commercial Fruit-Growing.** A study of the methods of propagation; the principles of budding and grafting; soils, varieties, and planting plans for the orchard; cultivation, cover crops, fertilization, spraying, and pruning, as practiced in orchard management; the picking, grading, packing, storing, and marketing of fruit. This course considers the apple, pear, quince, cherry,

plum, apricot, peach, grape, raspberry, blackberry, dewberry, current, gooseberry, and strawberry.

11. **Plant Diseases.** For description of this course see p. 15.

10. **Economic Entomology.** For description of this course see p. 15.

1. **Fertility of Land.** For description of this course see p. 13.

62. **Principles of Plant Culture.** This course is designed to give the student an elementary understanding of the structure and function of plants, with special reference to growth and reproduction.

II. VEGETABLE CULTURE

Required Subjects

61. **Vegetable Culture.** A study of the growing and marketing of vegetables for home use, and for the special and general market.

62. **Principles of Plant Culture.** See p. 30.
1. **Fertility of the Land.** See p. 13.
10. **Economic Entomology.** See p. 15.
11. **Plant Diseases.** See p. 15.

Elective Subjects

63. **Horticultural Reading.** Assignment of topics for abstracts and reports in standard works, bulletins, and current periodicals.

64. **Floriculture and Greenhouse Practice.** For description of this course see p. 32.

14. **Extension Work.** For description of this course see p. 15.
15. **Plant-Breeding.** For description of this course see p. 15.
16. **Farm Forestry.** For description of this course see p. 15.

III. FLOWER-GROWING

Required Subjects

64. **Floriculture and Greenhouse Practice.** A study of the growing and marketing of greenhouse crops. Designed to familiarize the student with the ordinary greenhouse operations.

1. **Fertility of the Land.** See p. 13.
10. **Economic Entomology.** See p. 15.
11. **Plant Diseases.** See p. 15.

Elective Subjects

63. **Horticultural Reading.** See p. 31.
5. **Horticulture.** See p. 14.
14. **Extension Work.** See p. 15.
15. **Plant-Breeding.** See p. 15.
16. **Farm Forestry.** See p. 15.

V. HOME ECONOMICS

Required Subjects

1. **Foods.** This course will include a study of food composition, food values, methods of selection, preparation, and preservation of food materials.

principles of nutrition, dietaries, care and feeding of children. Laboratory work will be given for application of the principles and will include practice in preparation of food and in serving.

2. **Household Sanitation.** The lectures in this course include a discussion of the sanitary conditions of the house and site; condition for health and for care of sick; the relation of bacteriology to the household.

3. **Household Management.** This course includes a study of the family income, cost of living, household accounts, problems of domestic service, methods of housekeeping, equipment, marketing.

4. **House Planning and Decoration.** An elementary course for the developing of economic house plans in accordance with architectural principles. Besides the work of drawing plans, the course includes discussions of the building site, building materials, elements of construction, laying out of the grounds, and criticism of interior design. The lectures of this course will apply principles of color and design to questions of interior decoration and furnishing. Students experiment with color combinations for decorative schemes, and with textile combinations for curtain-stuffs, wearing apparel, etc.

5. **Sewing and Drafting.** This course includes instruction in sewing, cutting, and fitting garments.

Elective Subjects

In addition to the courses outlined in home economics, opportunities are open to women to receive instruction in dairying, poultry husbandry, gardening, and extension work. Practical instruction may thus be had in milk and its products; feeding, care, and marketing of eggs and fowls; diseases of fowls; commercial fruit-growing, vegetable culture, floriculture, and ornamental gardening; public speaking. Women enter the regular classes in these subjects; but if a sufficient number desires work in home dairying a special class or section may be organized.

SUMMER SCHOOL

I. AGRICULTURE

The following courses, numbered one to fourteen inclusive, are intended primarily for school superintendents, high-school teachers, and others desiring to cover the field of agriculture in a general way during the Summer School. They are scheduled so that all may be taken without conflict; or one or more may be omitted and elective subjects from other groups added, as desired. The first seven courses will continue for three weeks, July 8 to 27, when they will be discontinued and the last seven (8 to 14) taken up for three weeks, July 29 to August 16.

Courses given during the first three weeks, July 8 to 27

1. **Animal Husbandry.** A discussion of the principles of feeding horses and dairy cattle, principles of breeding animals, and the historical development of the leading breeds of horses and dairy cattle.

2. **Economic Entomology.** A course in which the common insect pests of the farm, garden, and orchard are discussed and measures of control considered. The lectures will be illustrated by specimens, charts, and lantern slides. One laboratory period a week will be devoted to a study of the actual insects in the laboratory and field.

3. **Farm Crops.** Classification of farm crops; agricultural importance of various classes; and a brief study in classroom and laboratory of the principal types of importance in New York State.

4. **Poultry Husbandry.** The subjects to be discussed in the lectures are: the breeds; poultry-house construction; feeding for egg-production; marketing; rearing chickens; breeding for egg-production. The laboratory exercises include: judging the breeds; grading and candling eggs; study of the egg.

5. **Soils.** A practical course in soils, their primary characteristics and modes of handling. The lectures will include a discussion of the formation and classes of soils; tilth; soil moisture; soil amendments; fertilizers and manures; soil biology; and soil management from the standpoint of plant production. The laboratory work will consist in field trips and demonstrations. Some knowledge of geology and chemistry will be a great aid in pursuing this course.

6. **Vegetable-Gardening.** The lectures will include: a brief outline of the scope of the subject; a discussion of a few of the problems and methods that are peculiar to it; the planning and management of the home garden; vegetable crops from both home and commercial standpoints. The laboratory work will be planned to bring the student into touch with vegetable-gardening problems and practices, as illustrated in the College and in neighboring greenhouses and gardens.

7. **Weather, Climate, and Crops.** The fundamentals necessary to an understanding of the earth's atmosphere as a whole; the distribution and relation of temperature, pressure, winds, and moisture; the principles of weather forecasting; frosts and methods of protection; and the relation of weather and climate to general and special agriculture.

Courses given during the second three weeks, July 29 to August 16

8. **Agricultural Chemistry.** A discussion of the relations of chemistry to agriculture, including the sources of fertilizing materials, their preparation for use, and a study of the various forms of lime.

9. **Farm Management.** Lectures on the more important principles of farm management. Discussions and laboratory work on types of farming, cropping systems, farm accounts, farm layout, marketing, and successful farms.

10. **Farm Mechanics.** The work in this subject will be arranged to show the method of giving instruction in farm mechanics. Rope-splicing, belt-lacing, the plow, the grain binder, and the gasoline engine will be used as the subjects for laboratory study.

11. **Floriculture.** The lectures will include a brief outline of the scope of the subject; the use of flowers in and around the home; flower crops for the farm; flowers from a commercial standpoint; floricultural opportunities in the State and nation. The laboratory work is designed to give the student practice in the propagation, potting, shifting, and care of plants. The culture of the important flower crops will be illustrated by plants growing on the horticultural grounds.

12. **Milk and its Products.** The lectures will discuss bacteria in relation to dairy products; testing of milk; composition of milk; butter-making; cheese-making, with special reference to fancy cheese. The laboratories will include work on the nature of bacteria and their action on dairy products, and on the testing of milk for fat and for solids.

13. **Plant Diseases.** The lectures will discuss some of the more common diseases of fruit and other crops, with practical means of control. A microscopical study of the organisms causing these diseases will be made in the laboratory, together with an examination of the effect of the diseases on the plants. The relation of the control of the disease to the life history of the causal organism will be explained.

14. **Pomology.** A study of the principles and practice of fruit-growing. The topics considered are: methods of propagation, including budding and grafting; soils; varieties and planting plans; cultivation, cover crops, fertilization, spraying, and pruning; the picking, grading, and marketing of fruit.

II. AGRICULTURE

The following courses, each continuing for six weeks, are intended for persons desiring special training in the subjects. They are much more extended than those given above. With the outside study required, each will occupy one third to one half of the student's time. The courses are comparable with the introductory courses in the same departments given during the regular university year, and will be accepted for graduation in place of those courses.

A. **Agricultural Chemistry.** A general course treating of the relations of chemistry to agriculture and dealing with the composition and chemical properties of plants, soils, fertilizers, feeding-stuffs, insecticides, and fungicides.

B. **Agricultural Chemistry.** A laboratory course supplementing course A.

A. **Principles and Practice of Feeding Animals.** The general principles of animal nutrition; the study of feeding standards, the common grain and commercial feeds, the formulation of rations, etc.

B. **Principles of Animal-Breeding.** A general discussion of the principles of heredity as applied to the breeding of animals, with a study of animal form; origin and formation of breeds; crossing and grading, with an outline of the methods of registration and the study of records and pedigrees. Demonstrations, essays, and reports will be required in addition to the lectures.

A. **Farm Crops.** A general study of the principal cereal and forage crops in New York State, their distribution, important soil and climate requirements, and cultural methods.

A. **Farm Poultry.** The subjects discussed at the lectures are: the breeds; poultry-house construction; preparation of eggs for market; preparation of poultry for market; marketing of poultry and eggs; incubation; rearing of chickens; the principles of breeding; breeding for egg-production; poultry-farm management; feeding for egg-production; diseases of poultry. The subjects to be presented in laboratories are: judging the breeds; grading and testing eggs; grading and packing poultry; anatomy of poultry; study of the egg; study of feeds and sanitation.

A. **General Plant Physiology.** Lectures and laboratory work supplemented by field studies. The topics include absorption, metabolism, relation to environment, growth, reproduction, and propagative process.

B. **Special Problems in Plant Physiology.** Special work in certain phases of physiology, including ecology and fermentation.

A. **Milk Composition and Tests.** The topics considered are secretion and composition of milk, samples, lactometer, Babcock fat test, acid tests, moisture test, salt test, preservative tests.

A. **Plant Pathology.** A fundamental course treating of the common diseases of cultivated plants, their nature, cause, and control. A prerequisite to all other courses in plant pathology.

A. **Principles of Soil Management.** A fundamental course dealing with the origin, composition, and properties of soils with particular reference to their management in crop production. The laboratories will consist in practice designed to demonstrate fundamental physical relations, and will be supplemented by laboratory lectures.

III. NATURE-STUDY AND ELEMENTARY AGRICULTURE

Each of the following courses will continue throughout the six weeks of the Summer School.

A. **General Nature-Study.**

I. First three weeks: observation of the habits of common birds, with special reference to their nesting; the habits of the toad, frog, salamander, turtle, and other reptiles; special attention to the habits and haunts of common fishes; field notes on the habits of common wild mammals, including squirrels, chipmunks, mice, moles, woodchucks, etc.; a study of the natural habits and adaptations of some of the domestic animals, including the horse, cow, sheep, and pig; of the life histories of some common butterflies and moths, and other insects of orchard and garden; aquatic insects; and a study of the honeybee in observation hives.

II. Second three weeks: field observations on the life histories of the plants of the garden, open fields, moist ravines, marshes, and woods, special attention being given to the relation of the plants of the garden to their insect visitors; observations on the character, the habitat, and the fruit of common trees, especially fruit and nut trees, evergreens, and shade trees.

III. Lectures, first three weeks, to supplement and elucidate the field work in part I, including also the use of this material in the school, and the building and maintaining of breeding cages and aquaria.

IV. Lectures, second three weeks, on the habits, life histories, and uses of the plants and trees studied in part II, and the literature concerning them.

B. **Training Course in Natural History Method.** More careful and extended work in a few selected natural-history subjects. The work of the first three weeks will center about pond life; that of the second three weeks, about the relations between flowers and insects. The students will gather their own material, and a considerable part of the work will be done by each one individually and alone. Results will be rigidly graded, and university credit will be given for satisfactory completion of the course. Each student will provide himself with a good pocket lens, air and water nets, and the book containing outlines of the practical exercises. Membership in the class will be limited to twenty persons.

C. **Elementary Agriculture and Nature-Study.** Pedagogical work in elementary agriculture and nature-study as outlined in the New York State Syllabus. This course is designed for district superintendents, training-class teachers, and all other teachers interested in rural education. The Cornell Rural School Leaflet, in which is published subject-matter on the topics outlined in the New York State Syllabus, will furnish the text for this course. Subject-matter will be presented and schoolroom methods of conducting the lessons demonstrated. Professors in the College of Agriculture who have prepared the articles for the leaflet will give lectures and demonstrations. The fundamental educational value, as well as the economic importance, of school work in soils, animal husbandry, farm crops, gardening, fruit-growing, poultry, forestry, bird study, and the like will be discussed. Simple apparatus suitable for use in schools will be considered; also books for the school library. The Rural Schoolhouse will be made a center for working out some of the problems relating to school work in elementary agriculture and nature-study.

Excursions. 1. An afternoon on the farm with a naturalist and an agriculturist. 2. A night trip to the woods.

D. **Rural School Education.** This course will consider rural school conditions; the field of agriculture in education; the relations of school and community; teachers' associations; farmers' institutes; extension work; the relation of rural schools; the rural schoolhouse and grounds; the rural teacher; the rural library; and other topics of importance in rural education.

E. **School Gardening.** This course will include several lectures on school gardens in city and country; practical work on soils; preparing the ground; planting; caring for the garden; harvesting; exercises in judging garden plats; discussion of trees, vines, shrubs, and herbaceous plants suitable for the school garden; a child's home garden; discussion of window-boxes; the nature-study of the garden; literature.

F. **Textbook Work in Agriculture.** Designed to help teachers to use intelligently a textbook in agriculture in high schools or in the seventh and eighth grades. Demonstrations in connection with the lectures. Model lessons will be given with classes of girls and boys.

G. **Trips Afield.** A series of dawn and sunset walks, to some of the interesting places near the campus. The trips will be short, will not exceed an hour and a half in time, and will be entirely informal in character.

IV. HOME ECONOMICS

Each of the following courses will continue throughout the six weeks of the Summer School. All work is given on the fourth floor of the Main Building of the College of Agriculture.

A. **Foods.** A course for establishing a fundamental knowledge of foods. The lectures will include a discussion of the sources, composition, and characteristics of foodstuffs; principles governing the selection of foods and methods of preparing them; food preservation; comparative nutritive value and cost of various foods; selection, planning, and serving of well-balanced meals. The laboratory work, closely following the lectures, will consist of experiments in determining the characteristics of foodstuffs as these relate to the preparation of food and to practical problems of cookery.

B. **Human Nutrition.** A discussion of the methods of investigating dietary problems; the practical means of applying scientific principles in planning family and institution dietaries; consideration of special problems of nutrition, as in infant-feeding and feeding in cases of abnormal nutrition.

C. **Home Economics.** Domestic factors in cost of living; waste; standards of living; extravagance. Cost of food, shelter, clothing; marketing. Family budgets; distribution of income; savings. Domestic service.

D. **Household Sanitation.** Household bacteriology, cleanliness of soil, air, water, food; disposal of waste; insect pests, infection, immunity, methods of disinfection; good housekeeping in relation to public health; healthful living to promote efficiency; physical exercise and rest.

E. **Extension in Home Economics.** Principles of extension work with special reference to rural communities; organization; material to be presented; manner of presentation; speaking; writing.

V. ENTOMOLOGY

The instruction in entomology, formerly given in the University Summer Session, has now been transferred to the Summer School in Agriculture. The following courses will be continued throughout the six weeks of the Summer School. Students qualified to do advanced work will be granted the facilities of the laboratories, field stations, and library, after the close of the regular session. Members of the staff in residence during this period will be glad to consult with and aid such students.

A. **General Entomology.** An introductory course dealing with the biology, habits, economic importance, and relationships of insects.

B. **Laboratory Course in the Morphology and Classification of Insects.** Study of the external anatomy of typical insect forms; the collecting, mounting, and classifying of representatives of all the orders and the chief families of insects. While the systematic work will give a general survey of the field, each student may direct his energies toward the collecting of any group in which he is particularly interested.

C. **Research.** Opportunities will be offered for advanced work and research in various phases of entomology. Properly qualified students registered as candidates for advanced degrees may elect thesis work under any member of the Department who is in residence during the summer.

Seminary. The work of an entomological seminary is conducted by the Jugatae, an entomological club that meets for the discussion of current literature and of the results of investigations.

Special Courses

In addition to the work outlined above the following special afternoon courses, one week each, will be offered by various members of the Department. Emphasis will be placed on general principles and methods of work. Visitors who are especially interested in entomological subjects are invited to enroll for any part or for the entire series. Students who are registered for credit in the Department may count attendance on these courses as laboratory time.

1. **Aquatic Insects.** Lectures and field work illustrative of the biology of aquatic insects.

2. **Aquatic Insects,** continued, with special reference to their utilization as fish food.

3. **Economic Entomology.** Its problems and methods.

4. **Insects and Disease.** Lectures, demonstrations, and laboratory work on the work of insects and their allies in the transmission and dissemination of diseases of man.

5. **Photography and Lantern-Slide Making as an Aid to Entomological Work.** Lectures and demonstrations.

6. **Systematic Entomology.** Field and laboratory work designed to familiarize the student with special methods of collecting and preparing insects for the cabinet. At least one night excursion will be arranged.

OCTOBER, 1911 BULLETIN 304

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Animal Husbandry

SUBSTITUTES FOR SKIMMED MILK IN RAISING CALVES

WITH SUPPLEMENT SHOWING LATER DEVELOPMENT

A REVISION AND EXTENSION OF BULLETIN 269, PRINTED JULY, 1909

Under the direction of
HENRY H. WING

By E. S. SAVAGE and G. W. TAILBY, Jr.

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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

SUBSTITUTES FOR SKIMMED MILK IN RAISING CALVES

E. S. SAVAGE AND G. W. TAILBY, JR.

In New York State and, indeed, throughout the United States, the consumption of raw milk is increasing very rapidly. Milk is consumed in the cities in greater quantities every year, and in the country the production of cheese is utilizing the milk from an increasing area. The milk producer gets no skimmed milk from either the shipping station or the cheese-factory; therefore he must have some other food for raising his calves. In order to keep up his herd and to increase the quality and productive capacity of the herd from year to year, this food must fully take the place of skimmed milk. Whole milk is acknowledged to be the best food for calves, but the farmer cannot afford to feed this to his calves for any length of time. Skimmed milk with hay and grain probably makes the best substitute, but now that the supply of skimmed milk is being cut off, a satisfactory substitute for it must be found.

Several substitutes have been put on the market, said to fully take the place of skimmed milk for feeding calves and to keep them in good, healthy, growing condition. During the year 1907–8, this Station made a trial of two of these commercial foods, namely, Lactina Suisse, a vegetable milk powder manufactured in France, and Schumacher Calf Meal, put out by the Quaker Oat Company of Chicago. The data secured from the trial of these two foods as compared with skimmed milk were not considered sufficient, so the experiment was repeated in the year 1908–9. However, because of some changes in the method of keeping the records and because the trial was continued one month longer in 1908–9, it was considered best to write up the work of each year separately and then to consider the results of both years in formulating the general conclusions.

Before discussing the experiments in detail, we shall note the work that has been done on this question at other stations.

TRIALS AT OTHER STATIONS

There seems to have been very little work done on this question at the experiment stations, and the literature on milk substitutes for calf-feeding is scant. Mention of only three important experiments has been found in the experiment station literature, and a short resumé of them is here given.

Pennsylvania experiments.—The most extensive experiment was the work of Hayward at the Pennsylvania Station in the fall and winter of 1901–2.* The feeding trial in this case was with a calf meal prepared according to Hayward's own formula. In England, calf meals are fed by nearly every farmer, and Hayward took as a basis for his formula the following mixture, recommended by the agricultural colleges of England:

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* Pennsylvania Station Bulletin No. 60.

Flour	16⅔	pounds
Flaxseed-meal	33⅓	"
Linseed oil-cake meal	50	"

With this formula as a basis, a fairly satisfactory meal of the following composition was made Oct. 15, 1901:

Wheat flour	30	pounds
Cocoanut-meal	25	"
Nutrium	20	"
Linseed-meal	10	"
Dried blood	2	"

It was supposed that the wheat flour would serve to regulate the bowels, besides furnishing considerable nourishment. Only high-grade flour was used, but it was thought that a low grade of commercial flour might serve as well.

Cocoanut-meal is a by-product in the manufacture of cocoanut-oil. It was analyzed at the Pennsylvania Station and found to contain 20% protein and 9.03% fat. As cocoanut-oil is of a complex nature, the meal is likely to become rancid in a short time. The meal also has a strong odor of cocoanut-oil. For these reasons it might not be relished. It proved fairly satisfactory, however, in this trial.

Nutrium is a soluble skimmed milk powder manufactured by the National Nutrient Company at Jersey City, N. J. It is manufactured by drying skimmed milk at a comparatively low temperature and by a certain method of agitation. Nutrium has the appearance of wheat flour and, because it is dry, will keep indefinitely in a dry place. Its composition as determined by the Pennsylvania Station was:

Water	8.60%
Ash	6.62%
Protein	33.93%
Lactose	50.50%

Being virtually skimmed milk dissolved in water, it was thought that a great part of the success in the feeding of the calf meal was due to the nutrium used. The chief objection to the nutrium was its cost.

The properties of linseed-meal are too well known to need discussion. Dried blood is a product of the large abattoirs. The special brand used by Hayward is known as the Helmet Brand, and is sold by Armour & Company of Chicago. It is recommended as a cure for scours and perhaps also as a tonic. The cost of a pound of the entire mixture was estimated at 3.02 cents.

A few of the calves were reared on another meal of the following composition:

Corn-meal	13	pounds
Nutrium	20	"
Flaxseed	1½	"
Dried blood	2	"
Flour	30	"
Cocoanut-meal	6	"
Oat-chop (sifted)	6	"

This mixture was found to be a little more palatable perhaps, but did not seem to give quite so good results as the first mixture. The cost was approximately the same as the first mixture.

The calves in the experiment were not selected but were taken just as they were born, fed on whole milk for seven to ten days, and then gradually changed to the calf meal ration. They were fed twice a day from a calf feeder. All the calves that were fed the meal seemed to grow as well as the two calves which were raised on skimmed milk, hay, and grain and compared with the calf-meal fed calves as a check.

In the opinion of Hayward, as good and as thrifty calves can be raised on calf meal as on skimmed milk. He succeeded in rearing unselected calves without the aid of milk after the first 14 to 18 days. The calves weighed 150 to 250 pounds each when four to five months old, and were produced at a food cost of $8 to $9 each.

Massachusetts experiments.—J. B. Lindsey* made an experiment in 1903 with Hayward's mixture and with Blatchford's Calf Meal. Two thrifty grade Jersey calves were fed on Hayward's mixture and weighed respectively 310 and 260 pounds when six months and five and one-half months old. Calf No. 1 gained 1.4 pounds daily when on Hayward's mixture, and Calf No. 2, 1.1 pounds daily. The food cost of Calf No. 1 up to six months of age was $20.20, while calf No. 2 cost, up to five and one-half months of age, $15.11.

The calves were fed whole milk for the first 9 to 14 days, then skimmed milk and the meal mixture gradually substituted, the whole milk being entirely taken away at the end of three weeks. Three quarts of skimmed milk were fed daily, in addition to the meal mixture, until the calves were four to five weeks old, when both calves were placed on a diet of the meal mixture alone. One pound of this meal was stirred thoroughly into eight pounds of very hot water; this gruel was then allowed to cool until milk-warm, in which condition it was fed. The calves were taught to drink, instead of being fed with a calf feeder as Hayward recommended. Enough gruel to contain three-fourths pound of meal was fed at first, and the amount gradually increased, until at the end of the experiment calf No. 1 was getting three pounds per day and Calf No. 2, two pounds per day.

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* Sixteenth Annual Report, Massachusetts Hatch Station, Jan., 1904.

Blatchford's Calf Meal is put out by the Barwell Mills, at Waukegan, Ill., and is highly recommended by the manufacturers as a milk substitute. It is composed principally of linseed-meal, beans, carob-beans, cottonseed-meal and fenugreek. It was bought by Lindsey at retail at three and one-half cents per pound.

This calf meal was tested by feeding it to one rugged grade of Holstein calf. The calf was first fed whole milk for a few days, changed then to a mixture of whole and skimmed milk, and at the end of two or three weeks the calf meal was gradually substituted. The calf at first objected to the odor or taste of the meal, and never seemed thoroughly to relish it, although no serious difficulty was experienced in inducing the calf to take the gruel. One pound of the calf meal was stirred into six pounds of hot water, the gruel was allowed to cool and the mixture was fed milk-warm. When the calf was a little more than three months old, he was receiving two and three-fourths pounds of the meal daily, and continued to take this amount until the experiment ended when he was approximately four and one-half months old.

The animal grew well and suffered no serious digestive troubles. He made an average daily gain of 1.15 pounds during the last 42 days of the trial, and when four and one-half months old weighed 251 pounds.

Lindsey did not care to draw any definite conclusions from a single trial with one calf, but thought Blatchford's meal hardly as satisfactory as Hayward's mixture. He thought it hardly possible to raise delicate calves on the meal entirely.

Ontario experiments.—H. H. Dean* found that cocoa shell milk, made by boiling one-fourth pound of cocoa shells (not cocoanut shells) in two gallons of water, when fed one and one-half to two gallons per day with bran and oats, green feed, etc., appeared to be a very good substitute for skimmed milk and he thought it worthy of a trial by farmers who wish to raise calves and have little or no skimmed milk to feed. Cocoa shells are a by-product in the manufacture of cocoa and were purchased by Dean in Toronto for three cents per pound. The gain made by the calves fed on the cocoa shell milk, hay, grain, etc., compared very favorably with that made by the calves fed on skimmed milk, hay, and grain.

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* Annual Report of Department of Agriculture of Ontario, 1903. Vol. 1.

These three trials seem to constitute all the important work on this subject reported in experiment station literature. Other experiments have been reported, but they were made in connection with other work and the results were not satisfactory enough to warrant noting them in this connection.

I. EXPERIMENT AT CORNELL STATION, 1907–8

Three lots of calves, designated as A, B and C, were fed, respectively, skimmed milk, Schumacher Calf Meal, and Lactina Suisse. At the time the experiment was begun, several calves, one or two months old, that had been fed skimmed milk, were available, and although no record of the food had been kept, it seemed best to continue them as Lot A since the number of calves available for the experiment was limited. These calves undoubtedly had some advantages over the younger calves in Lots B and C. The calves in Lot B, with one exception, were also on hand but were younger than those of Lot A at the time of beginning the experiment, and none had had any skimmed milk although some had been fed Schumacher Calf Meal for a sufficient time to become accustomed to it. Table I gives the average age of the calves in each lot at the beginning of the experiment, Nov. 12, 1907. The calves of Lot A were on an average 52½ days old at the beginning of the experiment, those in Lot B 19½ days old, while the calves in Lot C were fed from birth according to the directions for feeding Lactina Suisse. In order to show the results at more nearly the same age, Table III has been prepared, showing the gains of Lot A for approximately the first 120 days after birth. This table shows that the calves of Lot A made an average daily gain of 1.62 pounds for the first 120 days after birth, which is a little less than the average gain of 1.76 pounds per day during the 120 days of the experiment.

Table I shows the age, breed, sex, weight at birth and summary of results with each calf in the experiment. In this table, in the second column " H " stands for Holstein, " J " for Jersey, " S " for Shorthorn and "A" for Ayrshire, the breed being designated by the first letter of its name. The letter " G," placed before the letter designating the breed, indicates that that particular calf is a grade of the breed named. Under sex, " H " stands for heifer and " B " for bull calf.

TABLE I. DETAILED STATISTICS OF CALVES, 1907–1908

Lot A. Fed skimmed milk, hay and grain

Calf No.	Breed	Sex	Date of birth	Weight at birth	Weight Nov. 12, 1907	Weight March 11, 1908	Total gain	Gain per day	Cost of one pound gain
				lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	
1	G.H	H	Oct. 4, '07	90	154	357	203	1.69	.050
2	J	H	Sept. 13, '07	47	137	334	197	1.64	.052
3	G.S	B	Oct. 13, '07	89	143	389	246	2.05	.042
4	H	H	Sept. 7, '07	91	203	431	228	1.90	.045
5	J	H	Aug. 31, '07	50	158	340	182	1.51	.065
Lot B. Fed Schumacher Calf Food, hay and grain									
6	H	H	Oct. 8, '07	87	122	289	167	1.39	.064
8	H	H	Oct. 18, '07	97	120	282	162	1.35	.079
9	H	H	Oct. 19, '07	95	127	290	163	1.35	.079
10	H	H	Oct. 23, '07	98	113	251	138	1.15	.093
11	Crossbred A & S	B	Oct. 28, '07	77	86	241	155	1.29	.073
13	G.S	H	Nov. 7, '07	87(?)	87	203	116	.97	.108
Lot C. Fed Lactina Suisse, hay and grain									
17	G.S	B	Nov. 18, '07	99	.....	168	*69	.61	.138
18	H	H	Nov. 18, '07	96	.....	180	*84	.74	.108
19	G.S	B	Nov. 23, '07	75	.....	(Mar. 2 1908) 155	*80	.72	.089
20	H	H	Dec. 4, '07	86	.....	171	*85	.86	.101
21	G.S	B	Dec. 14, '07	70	.....	118	*48	.55	.179

* Calf 17. Total gain from birth 114 days.
" 18. " " " " 114 "
" 19. " " " " 110 "
" 20. " " " " 98 "
" 21. " " " " 88 "

The commercial foods

Schumacher Calf Meal is a commercial product prepared by the Quaker Oats Company of Chicago. According to the manufacturers, this meal contains oat-meal, oat-germ, vacuum cooked wheat-meal, flax, and condensed milk. It is claimed in addition that the food has been subjected to processes which facilitate digestion. The chemical analysis as guaranteed by the Company is as follows:

Protein	19–21%
Carbohydrates	54–56%
Fat	8–9.5%
Fiber	3%

Lactina Suisse is a so-called vegetable milk powder manufactured at Vevey, Switzerland, and at Lyons, France. It is imported into this country and sold by John H. Lynch, New York, N. Y. It is claimed by the manufacturers that Lactina Suisse is made in powder form from vegetable matter almost exclusively, with the addition of some phosphate of lime. Its chemical composition as guaranteed by the manufacturers is:

Protein	29.75%
Fat	6.20%
Fiber	3.00%
Carbohydrates	44.01%
Soluble phosphate	2.52%
Indeterminate matter	7.22%
Water	7.30%

Methods of feeding

The calves were fed all the dry grain they would eat up clean each day. This grain was mixed according to the formula:

6 pounds corn and oats (ground half and half by weight)
3 pounds of wheat-bran
1 pound of oil-meal

Hay was kept before the calves at all times so that they could eat all they wished. This was mixed hay, with a good percentage of clover. Clean water was provided for each lot when the calves were judged to be old enough to need it. All the pails used in feeding were washed daily and scalded with hot water. The calves were kept in different pens, those of about the same age being kept together. The pens were cleaned often and were kept well bedded. The hay and dry grain were weighed daily for each pen, the amounts added for each 30-day period and the results averaged for each calf. The gruel from the calf meal and the Lactina Suisse, and the milk were weighed for each individual calf at each feed.

In computing the cost of feed for each calf, whole milk was considered to be worth $1.65 per hundredweight, the price paid by the Station Creamery to its patrons during the time the experiment was in progress. Skimmed milk was charged to the calves at 15 cents per hundredweight; hay at $10 per ton; corn and oats at $30 per ton; bran at $27 per ton; oil-meal at $34.50 per ton; making the cost of the dry grain mixture $29.55 per ton or $1.4775 per hundredweight. The Schumacher Calf Meal and the Lactina Suisse cost respectively three and one-half cents and six and one-half cents per pound delivered in Ithaca, N. Y.

The amounts of food consumed by each calf, cost of food, total gain, gain per day, and the cost of one pound of gain for each lot, are given below for the time the calves were kept under experiment in 1907–8.

Amount and cost of food for each calf for 120 days, 1907–8

The calves in Lot A (Fig. 1) were older than the others at the beginning of the experiment, and had been fed whole milk for three or four weeks after birth and then gradually changed to skimmed milk. The amount of skimmed milk was increased as the calves seemed to demand, until 22 pounds per day were fed, half in the morning and half in the evening. This milk was warmed to 90° F. when fed.

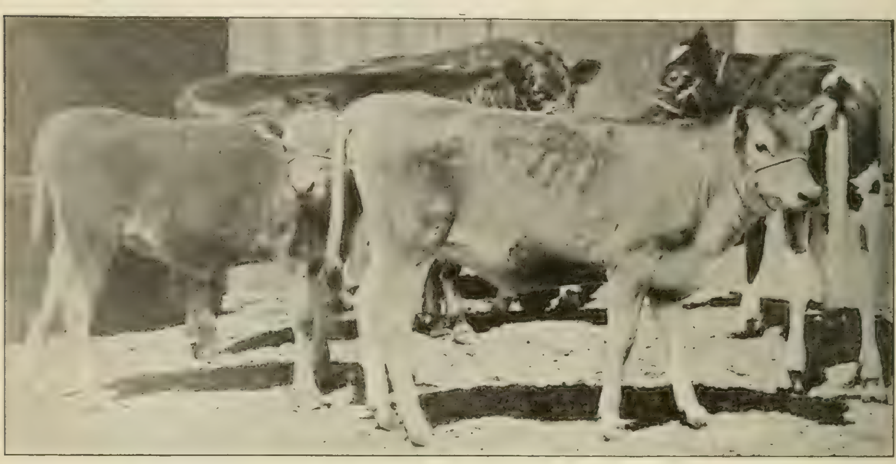


FIG. 1.—*Lot A at average age of 5 months. Average weight 370 pounds. Picture taken at end of the experiment*

The calves in Lot A grew very well and were not troubled with any digestive disorders.

The amount of food, cost of food and record of gain for the 120 days of the experiment is given for Lot A in Table II:

TABLE II. LOT A. FED SKIMMED MILK, HAY AND GRAIN

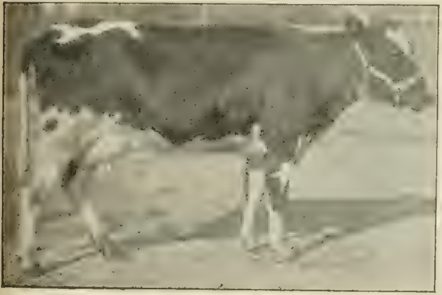
Calf No.	Skimmed milk	Hay	Grain	Cost of entire food	Total gain	Gain per day	Cost of one pound of gain
	lbs.	*lbs.*	*lbs.*		*lbs.*	*lbs.*	
1.........	2,488	374.9	311.8	10.21	203	1.69	.050
2.........	2,488	374.9	311.8	10.21	197	1.64	.052
3.........	2,488	374.9	311.8	10.21	246	2.05	.042
4.........	2,488	374.9	311.8	10.21	228	1.90	.045
5.........	2,488	374.9	311.8	10.21	182	1.51	.056

Since the calves in Lot A were older than the others at the time of beginning the experiment, Table III has been prepared to show the gains in weight for these calves for the first 120 days from birth:

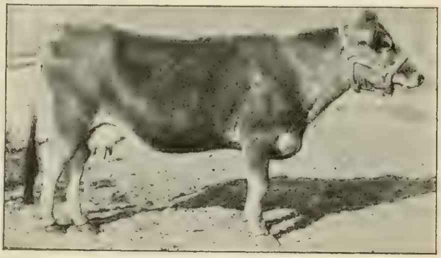
TABLE III. LOT A. SHOWING GAINS IN FIRST 120 DAYS AFTER BIRTH

Calf No.	Time	Number days	Pounds gain	Daily gain
				lbs.
1....	Birth to Feb. 12, 1908..................	129	210	1.62
2....	" " Jan. 12, 1908..................	120	180	1.50
3....	" " Feb. 12, 1908..................	120	211	1.75
4....	" " Jan. 12, 1908..................	126	221	1.75
5....	" " Jan. 12, 1908..................	133	198	1.48
	Average daily gain for lot................	....	....	1.62

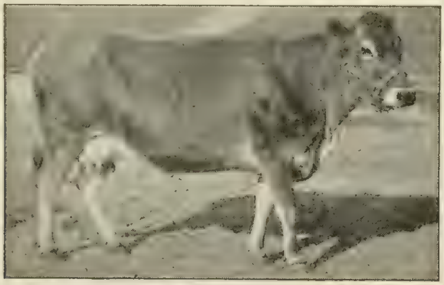
The cost of feed cannot be shown in this table because the records were not kept except for the gains in weight. This table was prepared in order that the gains of the calves at the same age might be compared, and we see by comparing it with Tables II, V, and VI, that the calves



CALF NO. 1



CALF NO. 2



CALF NO. 5

FIG. 2.—*Showing calves 1, 2, and 5 of lot A, Fig. 1, at three years of age*

fed skimmed milk made the best daily gains from birth. In Lots B and C, the records given in the other tables are for approximately the first 120 days after birth, making it unnecessary to make extra tables for those lots.

In Lot B (Fig. 3), calves Nos. 6, 8, 9, 10 and 11 were fed whole milk from birth up to the beginning of the experiment, the amount of milk varying with the age of the calf. Some Schumacher Calf Meal was also fed before Nov. 12, 1907, so they were all somewhat accustomed to it. Calf No 13 was fed from birth exactly in accordance with the directions which came with the meal. After Nov. 12, all the calves in this lot were fed as nearly as possible in accordance with the directions, except when the meal was refused or it seemed advisable from the standpoint of health to feed them otherwise.

The directions for feeding the Schumacher Calf Meal are as follows: Let the calf run with the cow or feed him whole milk until seven to ten days old, then begin using about two tablespoonfuls of meal to a pint of boiling water and two quarts of milk at a feed night and morning. Gradually increase the amount of meal until at the end of 14 days the amount for one feed is one quart of milk, three-fourths quart of meal mixed with one pint of cold water and then

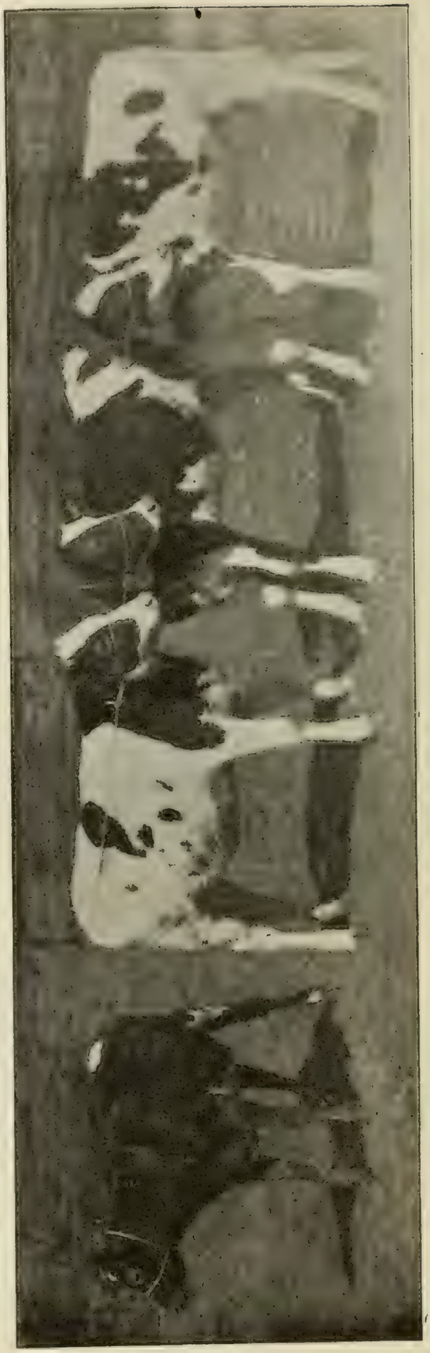


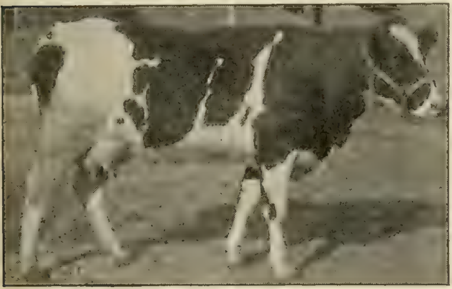
FIG. 3.—*Lot B at average age of 4 months and 20 days. Average weight 256 pounds. Picture taken at end of the experiment. Calves Nos. 6 and 11 are not shown as they were put on skimmed milk before the end of the experiment*

with one quart of boiling water added after the lumps are all stirred out in the cold water. Mix the milk and the meal gruel together at the time of feeding. As the calves grow older, they may be fed according to the following table:

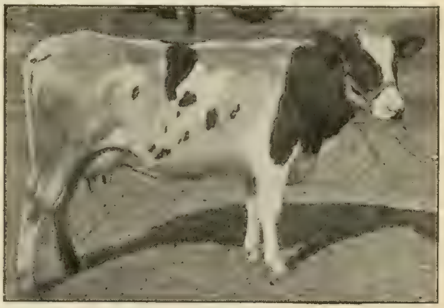
TABLE IV. TABLE FOR FEEDING SCHUMACHER CALF MEAL

Age of calf	Quarts of milk	Quarts of meal	Quarts of water	
			Lukewarm	Boiling
7– 14 days	I	¾	½	I
14– 21 "	I	¾	½	I
21– 28 "	½	I	¾	I
28–120 "	No milk	I	¾	I½

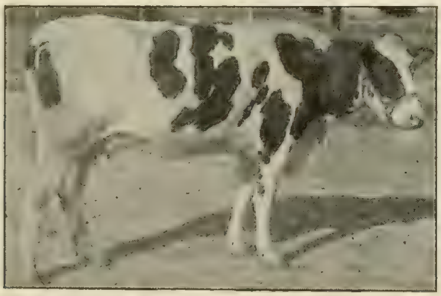
The amounts indicated in the above table are the maximum at the end of the periods named. The changes are to be made gradually. The amounts are for one feed and can be changed to suit the age and condition of the calf. The best results were obtained by mixing the gruel



CALF NO. 8



CALF NO. 9



CALF NO. 10

FIG. 4.—*Showing calves 8, 9 and 10 of lot B, Fig. 3, at three years of age*

sometime before feeding and then warming it again when ready to feed. The object in using a little cold or lukewarm water is to get the lumps all worked out before adding the boiling water. If boiling water is added directly to the meal it is almost impossible to get rid of the lumps.

The calves in Lot B made good gains on the Schumacher Calf Meal, and the cost of one pound of gain compared favorably with the cost of raising the calves in Lot A on skimmed milk.

Some trouble was experienced in getting the calves to take the meal gruel readily. The amounts called for by the directions seemed rather large in some cases and were cut down accordingly. One calf, No. 6, refused to take the gruel at all and was put on skimmed milk. Calf No. 11 did not seem to do well on the meal alone, so some skimmed milk was added to his ration.

TABLE V. LOT B. FED SCHUMACHER CALF FOOD, HAY AND GRAIN

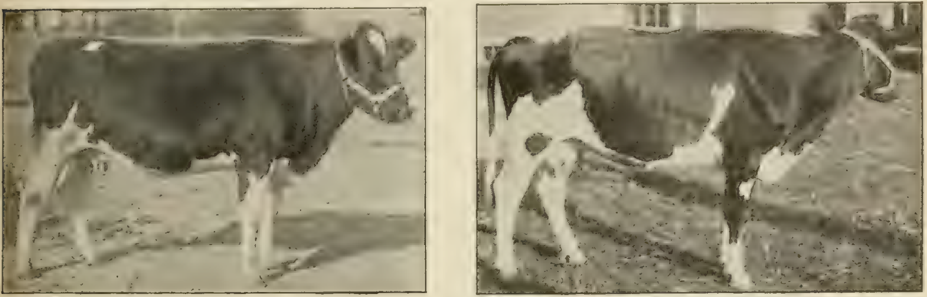
Calf No.	Whole milk	Skimmed milk	Schumacher	Hay	Grain	Cost of feed	Total gain	Gain per day	Cost of one pound of gain
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*		*lbs.*	*lbs.*	
6........	109.4	1,505	58.8	347.5	185.5	10.61	167	1.39	.064
8........	108.4		224.8	274.0	120.0	12.80	162	1.35	.079
9........	108.4		224.8	274.0	120.0	12.80	163	1.35	.079
10........	108.4		224.8	274.0	120.0	12.80	138	1.15	.093
11........	110.0	482	130.3	329.6	173.6	11.29	155	1.29	.073
13........	114.2		214.1	274.0	120.0	12.51	116	.97	.108

Table V shows for Lot B the amounts of the different feeds, cost of feed, total gain and average daily gain. Tables II, V, VI, and VII show that while the cost per pound of gain with Lot B is larger than with Lot A, yet the gains are very good and the cost moderate.

FIG. 5.—*Lot C at average age of 4 months. Average weight 159 pounds. Picture taken at end of the experiment*

Lot C (Fig. 5) was fed Lactina Suisse. The directions for feeding are as follows:

For the first seven to ten days after birth, feed whole milk; for the second and third weeks, one-third Lactina Suisse gruel and two-thirds milk; for the fourth, fifth and sixth weeks, one-half Lactina Suisse gruel and one-half whole milk; then gradually decrease the milk until Lactina Suisse gruel is being fed alone, increasing the amount of the gruel as the calf can take it. The gruel is made by mixing one pound of the Lactina Suisse powder with 19 pounds of boiling water. The dry powder is mixed with a little cold water first to get all the lumps out, and then the boiling water is added. This mixture, or gruel, is used like milk as regards quantity.



CALF NO. 18 CALF NO. 20

FIG. 6.—*Showing calves 18 and 20 of lot C, Fig. 5, at three years of age*

Table VI shows in detail the amount of feed eaten by Lot C, total gain, and average daily gain for each 30-day period. Tables II, V, VI, and VII show that the daily gain is lower and that the cost per pound of gain is higher with Lactina Suisse than with either skimmed milk or Schumacher Calf Meal at the same age. Yet the gains are large enough to warrant the statement that fair calves can be raised with Lactina Suisse.

TABLE VI. LOT C. FED LACTINA SUISSE, HAY AND GRAIN

Calf No.	Whole milk	Lactina Suisse	Hay	Grain	Cost of feed	Total gain	Gain per day	Cost of one pound of gain
	lbs.	*lbs.*	*lbs.*	*lbs.*		*lbs.*	*lbs.*	
17	190.3	51.48	263.0	119.0	9.57	69	.61	.138
18	191.5	43.16	263.0	119.0	9.05	84	.74	.108
19	173.2	36.72	187.4	65.2	7.15	80	.72	.089
20	302.0	27.35	181.9	64.6	8.62	85	.86	.101
21	321.0	21.95	181.9	64.6	8.59	48	.55	.179

The results with the several calves in each lot may now be averaged and summarized:

TABLE VII. SUMMARY OF TABLES II, V, AND VI, FOR 1907–1908

Lot	No. of calves	Average number of days in experiment	Average age at beginning	Cost of feed	Total average gain	Average gain per day	Average cost of one pound of gain
					lbs.	*lbs.*	
A	5	120	52.6	10.21	211.2	1.76	.048
B	6	120	19.6	12.14	150.1	1.25	.081
C	5	105	From birth	8.60	73.2	.70	.116

Conclusions from work in 1907–8

A careful study of Tables II, V, and VI, which summarize the results for each calf, and then of Table VII, which shows the average for each lot, warrants the following conclusions:

(1) While skimmed milk gives the best results as a substitute for whole milk, good strong calves can be raised without milk of any kind after the third or fourth week.

(2) It will cost at the present prices of milk, skimmed milk, hay, grain, etc., $12 to $15 to raise a calf to five months of age.

(3) Under normal conditions, a calf well cared for and properly fed should make an average daily gain of one to one and one-half pounds during the first four months of his life.

(4) Schumacher Calf Meal does not appear from this feeding trial to be a complete substitute for skimmed milk, yet the gains from the use of this meal are good and the cost of a pound of gain is fairly low.

(5) In the results derived from feeding Lactina Suisse, the gains per day became greater as the calves grew older, but this food did not seem to be nearly equal to skimmed milk or Schumacher Calf Meal at any corresponding periods of age.

II. EXPERIMENT AT CORNELL STATION, 1908–9

Since a part of the calves in the experiment of 1907–8 were older than the others, it was considered best to repeat the experiment in 1908–9, keeping a record of each calf from birth.

The calves to be fed on the different foods in 1908–9 were not selected in any way. The plan was to put each calf on experiment at birth and to feed equal numbers of calves on each food during the course of the experiment. From the results of 1907–8, it was considered not worth while to continue feeding Lactina Suisse because of its high cost and because of the generally poor results obtained by its use. The foods used for trial were skimmed milk, skimmed milk powder, Schumacher Calf Meal and Blatchford's Calf Meal. Calf No. 1 was fed Schumacher Calf Meal, calf No. 2 Blatchford's Calf Meal, calf No. 3 skimmed milk, and calf No. 4 skimmed milk powder. By alternating the calves as they were born during the fall, the lots fed on the different foods would thus have nearly equal numbers. However, owing to the fact that some of the bull calves were sold from time to time and thus dropped from the experiment, the calves in Lot D, fed skimmed milk, finally numbered seven, those in Lot E, fed skimmed milk powder, numbered six, Lot F, fed on Schumacher Calf Meal, numbered four, and Lot G, fed on Blatchford's Calf Meal, numbered four.

All records of food, weight, etc., were kept separately for each calf. The milk or gruel and the dry grain were weighed separately for each calf. The hay eaten by all the calves on experiment was weighed daily, and at the end of each month the amount of hay was averaged for each calf according to his age.

Each calf was kept on experiment from birth until he was 150 days old, or through the first five months of his life. Table VIII gives in brief the breed, sex, date of birth, etc., for each calf in the experiment.

Each calf was weighed at birth and every Thursday thereafter up to and including the last Thursday before he was 150 days old. He was then weighed when 150 days old. The record of these weighings for each individual is shown in Table IX. By weighing the calves each week, a check was kept on their development.

TABLE VIII. DETAILED STATISTICS OF CALVES, 1908–1909

Lot D. Fed skimmed milk, hay and grain

Calf No.	Breed	Sex	Date of birth	Weight at birth	Weight at end	Total gain	Gain per day	Cost of one pound of gain
			1908	*lbs.*	*lbs.*	*lbs.*	*lbs.*	
3..........	G. H	B	Aug. 29	85	287	202	1.35	.048
8..........	G. G	H	Sept. 8	62	255	193	1.29	.053
11..........	G. G	H	Sept. 12	83	320	237	1.58	.044
15..........	G. S	H	Oct. 3	62	290	228	1.52	.048
19..........	H	H	Oct. 22	68	329	261	1.74	.042
22..........	S	B	Nov. 9	68	303	235	1.57	.053
24..........	H	H	Nov. 12	83	328	245	1.63	.052

Lot E. Fed skimmed milk powder, hay and grain

4	H	B	Aug. 29	79	273	194	1.29	.061
6	H	H	Sept. 1	75	261	186	1.24	.060
12	H	H	Sept. 13	92	280	188	1.25	.065
16	J	H	Oct. 6	46	208	162	1.08	.065
20	J	H	Oct. 24	57	239	182	1.21	.062
23	S	H	Nov. 10	64	257	193	1.29	.069

Lot F. Fed Schumacher Calf Meal, hay and grain

1	H	H	Aug. 13	53	232	179	1.26	.083
5	H	H	Aug. 29	59	209	150	1.00	.106
13	J	H	Sept. 23	52	184	132	.88	.092
17	H & S	B	Oct. 8	91	282	191	1.27	.083

Lot G. Fed Blatchford's Calf Meal, hay and grain

2	H	H	Aug. 13	49	197	148	.99	.114
9	S	H	Sept. 10	62	170	108	.72	.157
14	H	H	Sept. 26	97	228	131	.87	.132
18	S	H	Oct. 10	78	214	136	.91	.135

The commercial foods

The skimmed milk powder was purchased from the Merrill-Soule Company of Syracuse, N. Y. The manufacturers claim for this product that it is simply ordinary skimmed milk dried by a patented secret process to a powder as fine as wheat flour. The grade used by this Station in this experiment was the third-grade product and was purchased at 2¼ cents per pound. The manufacturers inform us that through an improvement in the process this grade is no longer made except in very small quantities.

Schumacher Calf Meal has been fully described in the report of the work of 1907–8, page 8.

Blatchford's Calf Meal has been described by Lindsey as noted on page 6. It was purchased by this Station from J. W. Barwell, Waukegan, Ill., at four cents per pound delivered in Ithaca, N. Y. The analysis of this meal as guaranteed by the manufacturers is:

Protein	25%
Fat	5%

Methods of feeding

The methods used in feeding in 1908–9 were much the same as in 1907–8. The dry grain was mixed according to the formula on page 9. Clean water and mixed hay were kept before the calves at all times. The dry grain was weighed in 1908–9 for each individual calf, whereas in 1907–8

TABLE IX. WEEKLY WEIGHT RECORD OF INDIVIDUAL CALVES

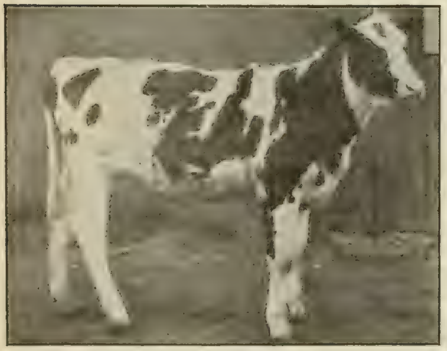
Calf No.	Breed	Sex	Born	5 months old	Birth weight	Weighings at intervals of one week																						
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Lot D. Fed skimmed milk, hay and grain																												
			1908	1909																								
3	G. H.	B	8/29	1/26	85	86	90	101	101	105	112	119	131	139	151	161	176	179	198	210	222	237	247	259	273	280	287	
8	G. G.	H	9/8	2/5	62	59	63	68	74	82	86	94	100	114	124	136	137	150	156	165	178	187	201	222	231	243	253	255
11	G. G.	H	9/12	2/9	83	83	88	95	99	103	114	122	140	151	162	166	183	197	210	223	238	251	271	286	299	308	320	
15	G. S.	H	10/3	3/2	62	61	68	74	80	91	99	110	116	132	141	156	168	181	195	210	222	238	248	259	269	281	290	
19	H	H	10/22	3/21	68	72	82	94	99	103	113	127	132	149	163	172	195	204	219	229	244	264	277	291	311	323	329	
22	S	B	11/9	4/8	68	67	70	73	87	95	106	110	122	132	145	153	163	181	194	207	214	221	240	255	276	281	303	
24	H	H	11/12	4/11	83	81	88	101	109	118	133	140	146	159	165	179	191	203	212	227	242	261	278	296	301	319	328	
Lot E. Fed skimmed milk powder, hay and grain																												
4	B	B	8/29	1/26	79	83	91	98	105	114	104	108	115	124	132	145	153	156	175	183	195	209	222	235	253	265	273	
6	H	H	9/1	1/29	75	85	94	98	100	104	104	112	120	129	138	150	152	167	175	190	201	212	224	236	249	260	261	
12	H	H	9/13	2/10	92	89	96	101	106	110	118	123	134	143	152	152	170	182	189	201	212	223	235	246	257	268	280	
16	J	H	10/6	3/5	46	47	55	60	64	67	74	78	81	92	96	109	119	128	137	143	151	158	167	179	187	197	207	208
20	J	H	10/24	3/23	57	58	66	73	78	79	89	96	104	114	124	133	143	152	164	176	186	196	206	217	228	236	239	
23	S	H	11/10	4/9	64	64	70	72	83	91	91	105	112	117	121	132	143	149	159	175	184	192	204	223	233	244	255	257
Lot F. Fed Schumacher Calf Meal, hay and grain																												
1	H	H	8/13	1/10	53	68	78	86	95	91	98	103	115	122	133	138	145	152	160	164	177	185	199	218	213	230	232	
5	H	H	8/29	1/26	59	65	69	76	81	83	91	100	104	109	117	123	132	133	143	148	161	164	178	188	196	203	209	
13	J	H	9/3	2/20	52	54	59	63	63	64	70	77	81	84	93	95	107	116	119	130	138	146	154	163	172	181	184	
17	H & S	B	10/8	3/7	91	87	96	102	107	111	117	124	134	145	160	171	175	190	203	210	220	236	242	260	270	278	282	
Lot G. Fed Blatchford's Calf Meal, hay and grain																												
2	H	H	8/13	1/10	49	60	68	70	72	72	66	81	91	101	107	115	124	130	139	140	154	160	169	179	183	195	197	
9	S	H	9/10	2/7	62	67	69	74	80	84	84	87	92	108	102	101	109	108	118	132	134	138	146	150	158	167	170	
14	H	H	9/26	2/23	97	90	100	105	102	102	109	113	121	119	135	134	142	148	148	162	175	184	198	201	212	221	228	
18	S	H	10/10	3/9	78	77	84	84	89	95	100	100	107	111	121	130	134	142	150	154	162	173	179	191	197	204	214	

CALF NO. 3

CALF NO. 8

CALF NO. 11

CALF NO. 15



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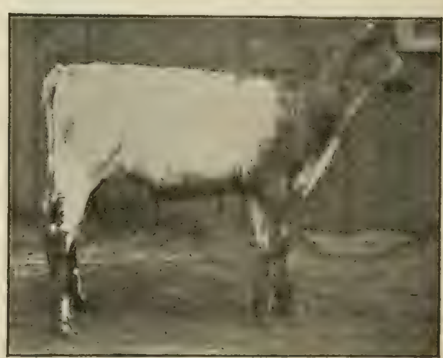
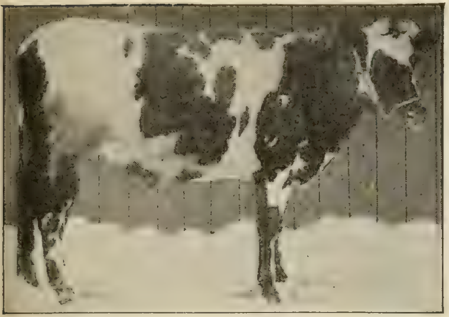


CALF NO. 22

FIG. 7.—*Lot D at 5 months of age. Average weight 302 pounds*



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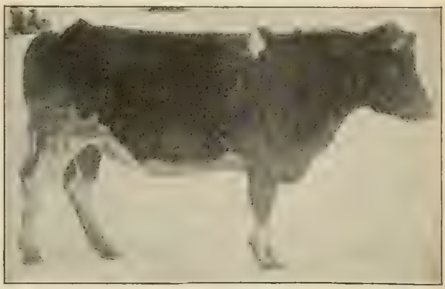

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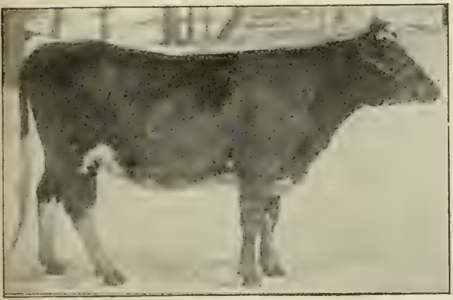

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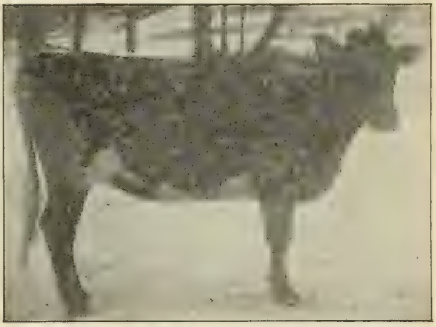

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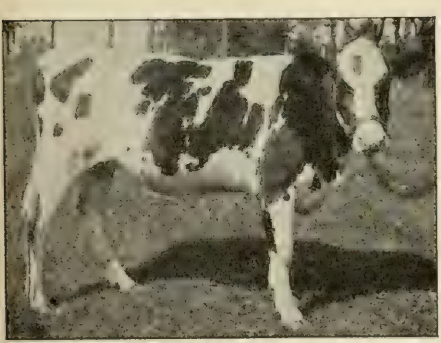

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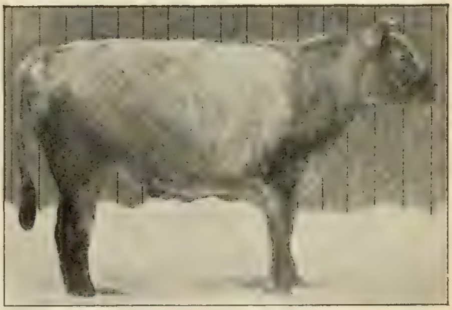


CALF NO. 22

FIG. 8.—*Showing calves 3, 8, 11, 15, 19, and 22 of lot D, Fig. 7, at two years of age*

the grain was weighed for a lot and then averaged for the individuals. The hay was weighed for all the calves and then averaged for each calf according to his age. The milk and gruel of all kinds was weighed for each individual calf at each feed.

In computing the cost of feed for each calf, the same prices were charged for each food in 1908–9 as in 1907–8, in order to make comparisons more uniform.

In 1907–8, some of the calves were troubled with scours. In order to avoid this trouble, about one tablespoonful of blood flour was mixed with each feed for each calf. The blood flour is sold by Swift and Company of Chicago, and under the name "Soluble Blood Flour." The manufacturers state that this material, which is a by-product from the abattoirs, will prevent scours. It is sold for $1.50 per hundredweight, and since the cost was so small no account has been taken of the cost of the amount used. The effect of the blood flour on the digestion was good, keeping the calves in good condition. The manufacturers state that this blood flour contains 47% protein, so that as a food its effect would be good on growing calves; but in this experiment it was not intended as a food but for the control of digestive troubles.

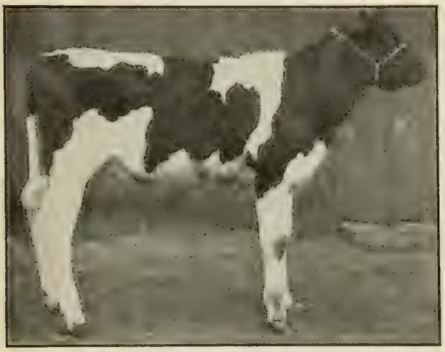


FIG. 7a.—*Calf No. 24, lot D, at 5 months of age (see Fig. 7)*

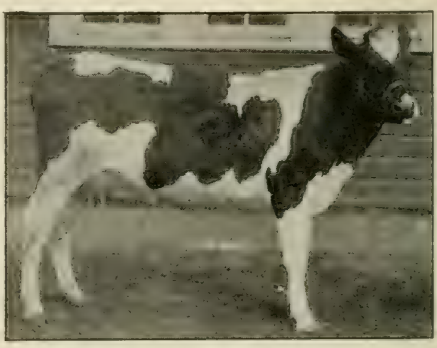


FIG. 8a.—*Showing calf 24, lot D, Fig. 7a. at two years of age*

The amounts of food eaten by the different lots of calves, together with the cost of feed, total gain, and the cost of one pound of gain, are given below for each group. The amounts of feed were kept for each day's feeding, the totals were added at the end of each month, and the sum of these totals for the five months from birth for each calf is given in the tables.

Amount and cost of food for the five months from birth for each calf

TABLE X. LOT D. FED SKIMMED MILK, HAY AND GRAIN

Calf No.	Whole milk	Skimmed milk	Hay	Grain	Entire cost of feed	Total gain	Cost of one pound of gain
	lbs.	*lbs.*	*lbs.*	*lbs.*		*lbs.*	
3	109.	2626.	341.8	150.	9.67	202	.048
8	178.	2383.	285.2	154.	10.22	193	.053
11	156.	2542.	295.2	169.	10.36	237	.044
15	155.	2438.	429.7	174.	10.94	228	.048
19	148.	2553.	447.2	159.	10.86	261	.042
22	315.	2441.	362.7	120.	12.44	235	.053
24	351.	2359.	362.7	100.	12.62	245	.052

The calves in Lot D (Figs. 7 and 7a) grew very well and were not troubled to any extent with digestive troubles. In Table IX it is shown that they each reached a weight of over 250 pounds at the end of five months, that is, at five months of age, and in Table X it is shown that the entire food cost ranged from $9.67 for calf No. 3 to $12.62 for calf No. 24.

With Lot E, *Table XI*, (Fig. 9), the milk powder gave very good results. The food was prepared as follows: One pound of the milk powder was dissolved in nine pounds of water, this being practically the proportion of solids to water in ordinary skimmed milk. The powder was sifted to get out the lumps, then mixed with a little cold water, and finally boiling water was poured on and the whole mixed. This method gave the best results, ensuring a liquid free from lumps, which served as skimmed milk in every way, the amount given at a feed being the same as of skimmed milk and fed at the same temperature.

In Table IX it is shown that the calves fed on the milk powder reached a weight of 208 pounds to 280 pounds at five months of age.

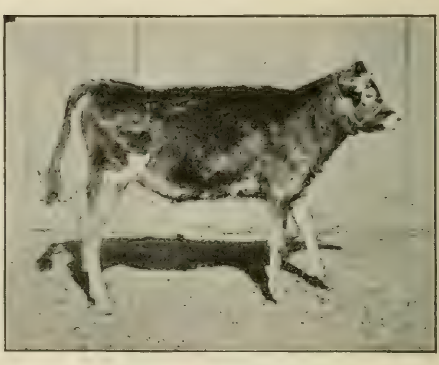
TABLE XI. LOT E. FED SKIMMED MILK POWDER, HAY AND GRAIN

Calf No.	Whole milk	Skimmed milk powder	Hay	Grain	Entire cost of feed	Total gain	Cost of one pound of gain
	lbs.	*lbs.*	*lbs.*	*lbs.*		*lbs.*	
4	124.	231.8	531.8	135.	11.92	194	.061
6	133.	237.5	341.8	135.	11.23	186	.060
12	198.	247.2	308.9	135.	12.36	188	.065
16	162.	220.7	324.4	90.	10.59	162	.065
20	174.	236.7	352.9	85.	11.22	182	.062
23	318.	203.9	362.7	105.	13.20	193	.069

CALF NO. 4

CALF NO. 6

CALF NO. 12



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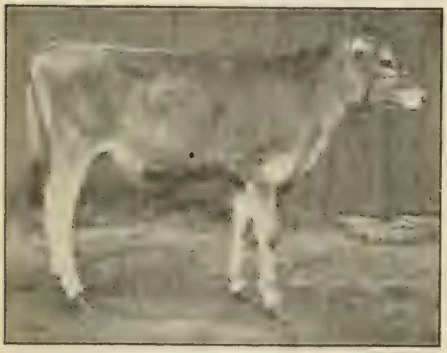

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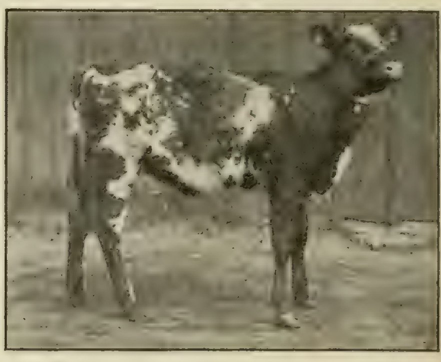
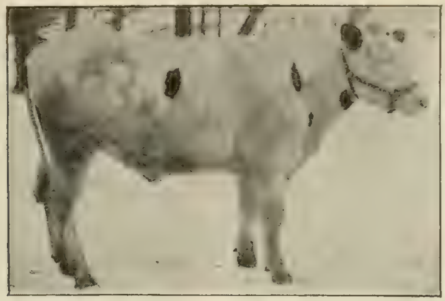


CALF NO. 23

FIG. 9.—*Lot E at 5 months of age. Average weight 253 pounds*



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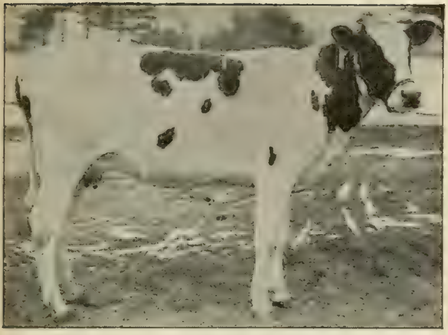

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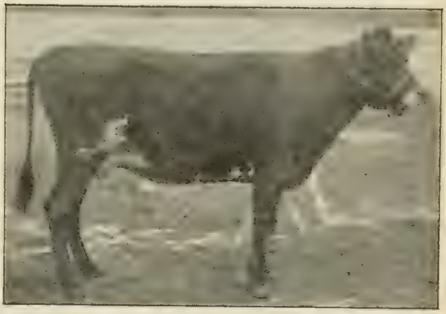

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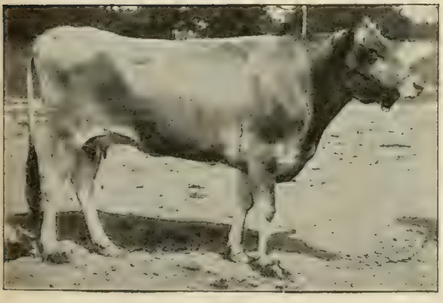

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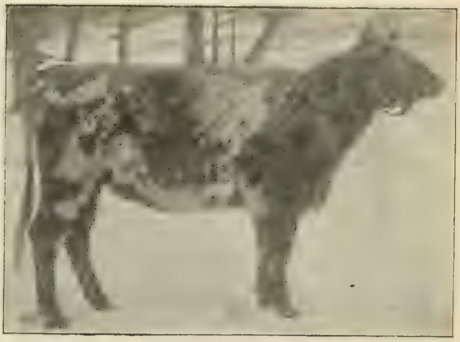
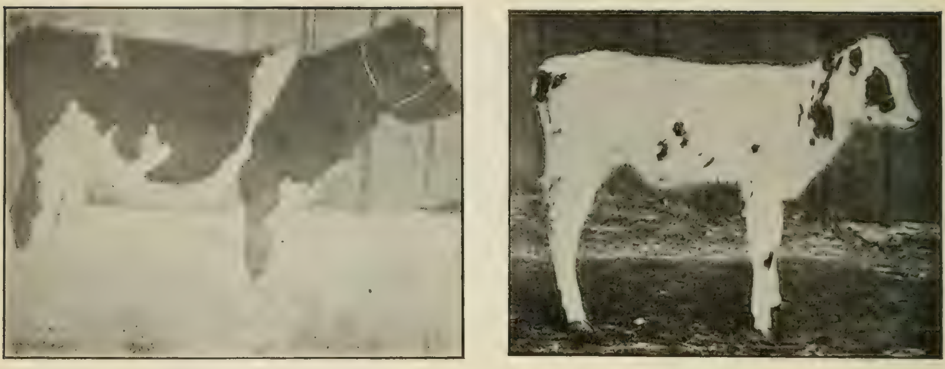


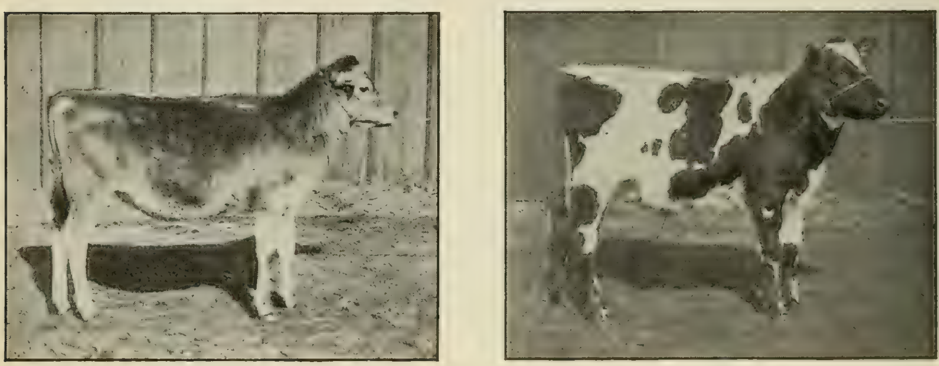
CALF NO. 23

FIG. 10.— *Showing calves 4, 12, 16, 20, and 23 of lot E, Fig. 9, at two years of age*



CALF NO. 1

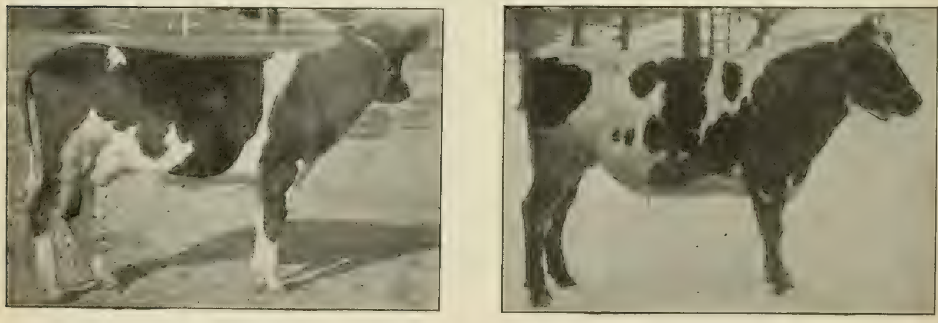
CALF NO. 5



CALF NO. 13

CALF NO. 17

FIG. 11.—*Lot F at 5 months of age. Average weight 227 pounds*



CALF NO. 1

CALF NO. 17

FIG. 12.—*Showing calves 1 and 17 of lot F, Fig. 11, at two years of age*

The cost of raising these calves to five months of age was $10.59 to $13.20, according to Table XI.

The calves in this lot did very well and the raising of the calves on this food was as easy as on skimmed milk, hay and grain.

TABLE XII. LOT F. FED SCHUMACHER'S CALF MEAL, HAY AND GRAIN

Calf No.	Whole milk	Schumacher Calf Meal	Hay	Grain	Entire cost of feed	Total gain	Cost of one pound of gain
	lbs.	*lbs.*	*lbs.*	*lbs.*		*lbs.*	
1	304.	210.4	232.2	85.	14.80	179	.083
5	269.	227.2	341.8	120.	15.87	150	.106
13	142.	184.1	406.9	95.	12.21	132	.092
17	190.	259.2	334.4	135.	15.87	191	.083

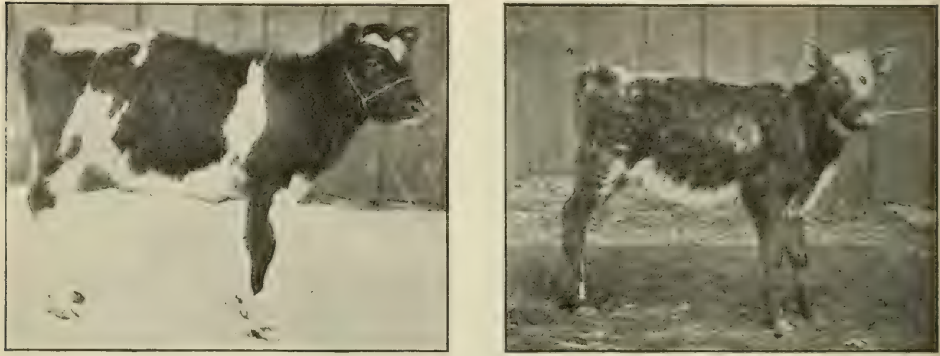
Lot F, Table XII (Fig. 11).— In feeding Schumacher Calf Meal, the gruel was made the same as in 1907–8, as given on pages 12 and 13. The amount given at a feed was governed by the age and size of the calf. The calves of this lot, according to Table IX, reached a weight at five months of age of 184 pounds to 282 pounds, at a cost of $12.21 to $15.87, as shown in Table XII. The results show that the calves did fairly well but did not make the gains that the calves in Lots D and E made.

TABLE XIII. LOT G. FED BLATCHFORD'S CALF MEAL, HAY AND GRAIN

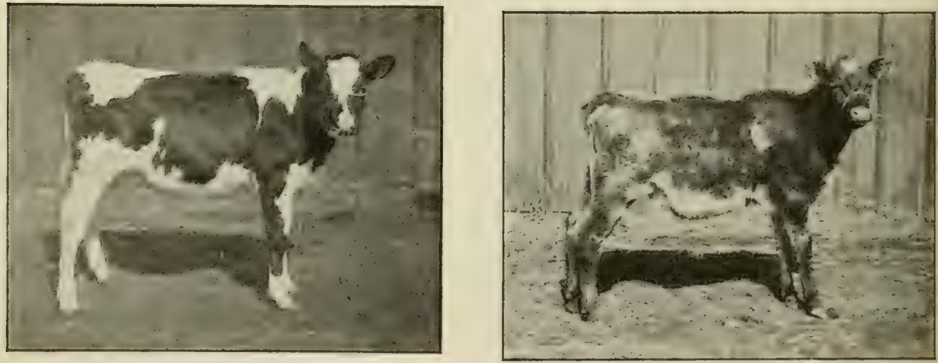
Calf No.	Whole milk	Blatchford's Calf Meal	Hay	Grain	Entire cost of feed	Total gain	Cost of one pound of gain
	lbs.	*lbs.*	*lbs.*	*lbs.*		*lbs.*	
2	302.	233.9	232.2	90.	16.83	148	.114
9	213.	267.7	289.9	90.	17.00	108	.157
14	144.	273.2	406.9	130.	17.26	131	.132
18	168.	306.4	302.9	125.	18.39	136	.135

Lot G, Table XIII (Fig. 13).— In feeding Blatchford's Calf Meal, the gruel was made as follows: The meal was mixed with a little cold water to avoid lumps, then enough hot water was added to make sufficient gruel for the number of feeds required. The gruel was set aside until cool. If too cold at time of feeding, it was warmed again to 90° to 100° F. When the meal was first fed to the young calf, a tablespoonful of the meal was mixed into gruel in this way and added to the whole milk. The whole milk was then gradually reduced until the calf took the meal gruel entirely. The amount of calf meal fed per day varied from a tablespoonful in the beginning with the whole milk, up to two and one-fourth pounds per day. The amount of calf meal varied with the age and size of the calf.

The use of Blatchford's Calf Meal did not bring very satisfactory results. In Table IX it is seen that the weights reached at the end of five months varied from 170 pounds to 228 pounds. The cost of raising a calf with Blatchford's Calf Meal up to five months of age was $16.83 to $18.39. While these weights are fairly good, yet they are the lowest made in 1908–9, and the cost is too high for the meal to be used economically.



CALF NO. 2 CALF NO. 9



CALF NO. 14 CALF NO. 18

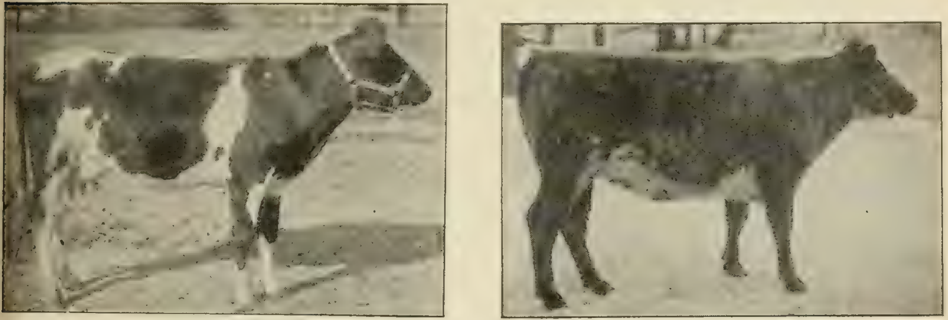
FIG. 13.—*Lot G at 5 months of age. Average weight 202 pounds*

Conclusions from work in 1908–9

Table XIV has been made from Tables VIII, X, XI, XII, and XIII, in order to summarize the results of the work for 1908–9.

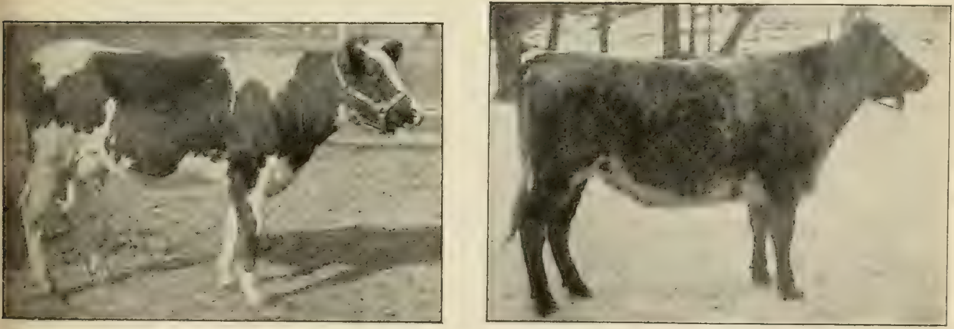
TABLE XIV. SUMMARY OF TABLES VIII, X, XI, XII, AND XIII FOR 1908–1909

Lot	No. of calves in lot	Food used	Wt. at birth	Wt. at end of 5 mos.	Total gain	Experimental food	Whole milk	Hay	Dry grain	Entire cost of feed	Average gain per day	Average cost of one pound of gain
			lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*		*lbs.*	
D.....	7	Skimmed milk..	73	302	229	2478.	202	360.6	146.6	11.02	1.53	.048
E.....	6	Skimmed milk powder......	69	253	184	229.6	185	370.4	114.1	11.75	1.23	.064
F.....	4	Schumacher Calf Meal...	64	227	163	220.2	226	328.8	108.7	14.69	1.10	.090
G.....	4	Blatchford's Calf Meal...	72	202	130	270.3	207	307.9	108.7	17.37	.87	.134



CALF NO. 2

CALF NO. 9



CALF NO. 14

CALF NO. 18

FIG. 14.—*Showing calves 2, 9, 14, and 18 of lot G, Fig. 13, at two years of age*

A careful study of the above table, together with the tables from which it was made, gives data from which conclusions may be drawn. These are essentially the same as those drawn from the first year's work (page 16).

(1) Skimmed milk gave the best results as a substitute for whole milk, yet the other foods, skimmed milk powder, Schumacher Calf Meal and Blatchford's Calf Meal, gave fair results, good strong calves having been raised by their use without any milk after the calves were four weeks of age.

(2) The dried skimmed milk powder was worth the most as a substitute for skimmed milk at an economical cost.

(3) Schumacher Calf Meal gave about the same results as in 1907–8, but it is not an economical food if the third-grade dried skimmed milk powder can be procured for feeding.

(4) Blatchford's Calf Meal is in about the same class as the Lactina Suisse, which was tried in 1907–8. The calves did not do well on this food and the cost of raising is much too high.

SUMMARY FROM THE RESULTS IN 1907–8 AND 1908–9

(1) It is evident from the results of these experiments and those elsewhere that good, strong, healthy calves can be raised without skimmed milk or milk of any kind after the first thirty days.

(2) Skimmed milk, hay, and grain, make the best substitute for whole milk in raising calves. A calf fed on skimmed milk should reach a weight of 300 pounds at five months of age, and the gain should be made at the rate of one and one-half pounds per day, at a cost of less than five cents per pound.

(3) If skimmed milk is not at hand, the best substitute for it seems to be third-grade dried skimmed milk powder. The average gains made in this experiment were not so large as with the skimmed milk, but were good. A calf fed on this food should reach a weight of 250 to 260 pounds at five months of age, making an average gain of 1.25 pounds per day at a cost of less than six and one-half cents per pound.

(4) Schumacher Calf Meal seems to be the best commercial substitute, in the nature of grain, for skimmed milk on the market at the present time. The calves fed on this food gained on an average 1.25 pounds per day in 1907–8 and 1.10 pounds per day in 1908–9. The average cost per pound of gain was between eight and nine cents.

(5) Blatchford's Calf Meal, while good enough for raising fair-sized calves, is too expensive to feed ordinarily.

(6) Lactina Suisse gave results comparable with Blatchford's Calf Meal. It is too expensive to feed and the results from it were too poor to warrant its use when any other food can be obtained.

(7) A tablespoonful of soluble blood meal mixed with each feed served to keep the bowels of the calves in better condition, and since it is comparatively inexpensive a wider use of it might be profitable.

By comparing the photographs of the calves in the different groups (Figs. 1, 3, 5, 7, 9, 11, and 13), a fairly good idea can be had of the kind of calves produced with the different foods.

III. SUPPLEMENT SHOWING DEVELOPMENT OF CALVES AS TWO-YEAR-OLDS AND THREE-YEAR-OLDS

As a supplement to the foregoing, pictures are given of the animals now in the college herd that were under experiment as calves. The purpose of these pictures is to show that, as two-year-olds and three-year-olds, there is apparently no less constitutional vigor manifested by the animals that were in poorer condition at five months of age, due to feeding them substitutes for skimmed milk, than by the animals which received skimmed milk and which were in better condition at that age.

1. *Animals fed as calves in* 1907–1908.— Comparing Figs. 1, 3, and 5, we see that, as calves, those animals fed skimmed milk were decidedly the best in appearance, those fed Schumacher Calf Meal were next, and those fed Lactina Suisse were the poorest. This fact is further emphasized in comparing the average daily gains in Table VII. Lot A, fed skimmed milk, made an average daily gain of 1.76 pounds; Lot B, fed Schumacher Calf Meal, 1.25 pounds; Lot C, fed Lactina Suisse, .70 pounds.

The heifers now in the herd from Lot C, calves Nos. 18 and 20, shown in Fig. 6 as three-year-olds, developed into as good heifers as any in the herd raised from calves in 1907–8, notwithstanding their poor start on Lactina Suisse. They are as fine in appearance as any in Lots A or B, and seem to have as much constitutional vigor; and in their production during their first lactation period they have excelled all of the heifers from Lots A and B. The three heifers shown in Fig. 4, which were calves Nos. 8, 9, and 10 of Lot B, fed Schumacher Calf Meal, are the equal in constitutional vigor and appearance of the heifers raised from Lot A, as shown in Fig. 2.

2. *Animals fed as calves in* 1908–1909.— The same general condition is found on comparing the pictures of the two-year-old heifers raised as calves in 1908–9 as was found for the calves raised in 1907–8. The

calves raised in 1908–9, showing the least thrift, were those fed on Blatchford's Calf Meal. These are shown as calves in Fig. 13; as two-year-olds they are shown in Fig. 14. Their gains per day as calves averaged .87 pounds, whereas the calves in Lot D, fed skimmed milk, made a gain of 1.53 pounds. (Table XIV.)

The same is true of the calves in Lot F, Fig. 11, fed Schumacher Calf Meal. They have developed into animals of as good appearance and as strong constitution as any of the animals raised from the calves of 1908–9. In general it may be said that all the two-year-olds raised from the calves of 1908–9 are of equally good constitutional vigor so far as any influence may be attributed to the condition of the calves at five months of age, due to the feeding of substitutes for skimmed milk.

In some lots some of the individuals shown as calves are not shown in the pictures representing the later development of the lot. This is for two reasons: The males not shown in the later pictures have been slaughtered, and the females not shown have died from one cause or another in no way connected with the experiment.

SUMMARY

The writers of this supplement do not wish to put themselves on record as maintaining that it does not matter how calves are fed, that the results when they become two or three years old will be the same in any case. Rather, it is intended to show that the heredity of the animal is of more consequence than any moderate influence in the care or feeding for a short time at the beginning of the development of the individual. If the calf is not stunted permanently by continuing poor feed for too long a time, the lack of thrift which might result from using a substitute for milk from the time the calf is ten days or two weeks old until he is on hay and grain entirely, may be overcome in the later development of the animal if the dry food given from the time he is five months of age is proper and sufficient in amount.

OCTOBER, 1911 BULLETIN 305

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Animal Husbandry

THE CAUSE OF "APOPLEXY" IN WINTER-FED LAMBS

INVESTIGATION UNDER DIRECTION OF

H. H. WING

SUPPLEMENTARY TO BULLETIN 285

ITHACA, N. Y.
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THE CAUSE OF "APOPLEXY" IN WINTER-FED LAMBS

Investigations at Cornell University Agricultural Experiment Station in 1910–11

In order to get further data on the cause of "apoplexy" in winter-fed lambs, an experiment was conducted at the Cornell University Agricultural Experiment Station in the winter of 1910–11, on much the same plan as the cooperative experiment at the farm of Chas. E. Shepard, Batavia, N. Y., in 1909–10, described in full in Bulletin 285.

PURPOSE OF THE 1910–11 INVESTIGATION

The purpose of the investigation in 1910–11 was three-fold:

(1) To ascertain the cause of apoplexy in lambs;

(2) To determine the relative cost of gain in weight with narrow and with wide rations;

(3) To determine the relative cost of gain in weight with rations with succulent feed and with rations without succulence.

THE LAMBS

The feeding lambs used in the experiment were bought on the Chicago market in the usual way. They were rather small, tending toward "pony build." They showed some fine wool blood but evidently carried more "down" blood than anything else. There were very few white faces among them. Of the 325 lambs bought, 306 cost on the Chicago market $6.35 per hundredweight, and 19 cost $6.44 per hundredweight. They weighed an average of 50 pounds in Chicago. From these 325 lambs, 289 were selected for the investigation.

PLAN OF THE INVESTIGATION

The lambs were divided into four lots: Lot A contained 58 lambs, divided into pens 1, 2 and 3; Lot B contained 58 lambs, divided into pens 4, 5 and 6; Lot C contained 86 lambs, divided into pens 7, 8, 9 and 10; Lot D contained 87 lambs, divided into pens 11, 12, 13 and 14. The pens were arranged as shown in Fig. 15. This drawing also shows the distribution of the lambs among the pens. The double pens, containing 29 lambs each, were 10½ by 15 ft.; the single pens, containing in some cases 14 lambs and in others 15 lambs, were 5 by 15 ft. As is shown in the illustration, all the lambs were fed from double racks, one hole being provided for each lamb. The type of double rack used is well illustrated in Fig. 16. The rack was 18 in. wide at the top, and tapered to 12 in. wide at the bottom.

To carry out the three purposes of the experiment as given on page 35, Lot A was fed a wide ration with silage for a succulent food; Lot B, a wide ration without silage; Lot C, a narrow ration without silage; and Lot D, a narrow ration with silage. It was planned to have the pens

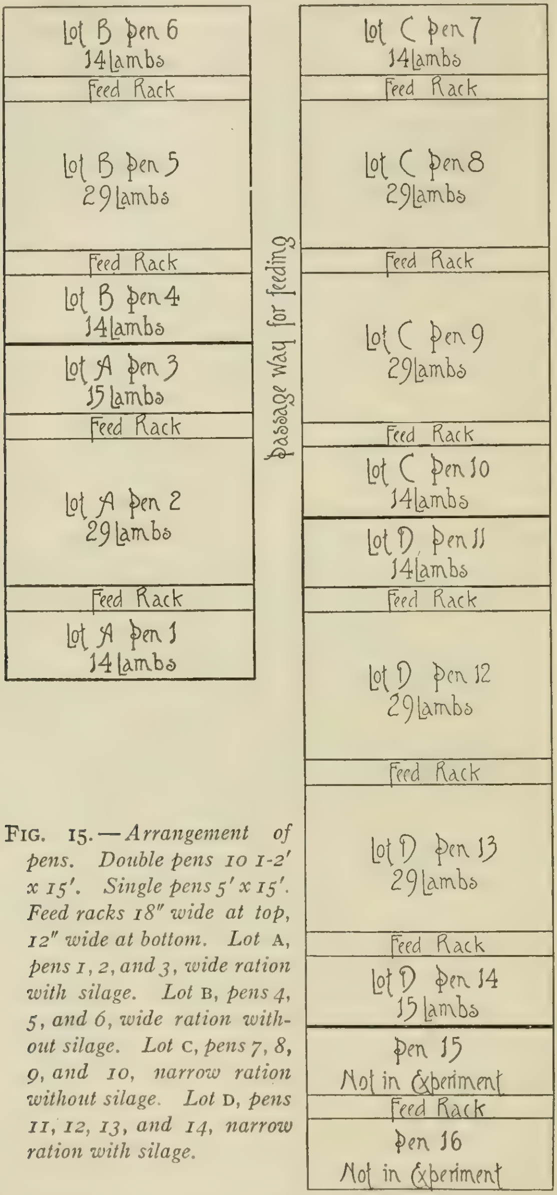

FIG. 15.—*Arrangement of pens. Double pens 10 1-2′ x 15′. Single pens 5′ x 15′. Feed racks 18″ wide at top, 12″ wide at bottom. Lot* A, *pens 1, 2, and 3, wide ration with silage. Lot* B, *pens 4, 5, and 6, wide ration without silage. Lot* C, *pens 7, 8, 9, and 10, narrow ration without silage. Lot* D, *pens 11, 12, 13, and 14, narrow ration with silage.*

full at all times during the first part of the experiment, with only one feeding place in the rack for each lamb. If for any reason a lamb had to be removed from a pen, he was immediately replaced by another lamb as near his size and weight as possible. Two extra pens of lambs, 15 and 16, made up from those not used for the experiment, were fed at the same time to provide lambs to replace any that might die during the experiment. It was expected that the feeding of these four lots kept in full pens would give reliable data as to the relative values of wide and narrow rations, the value of succulence in the ration, and the effect of the four different rations on the prevalence of "apoplexy" when the lambs are cared for in a normal way. For further data concerning the cause of apoplexy, some of the lambs were continued after the main experiment was finished. These subsequent data will be discussed later.

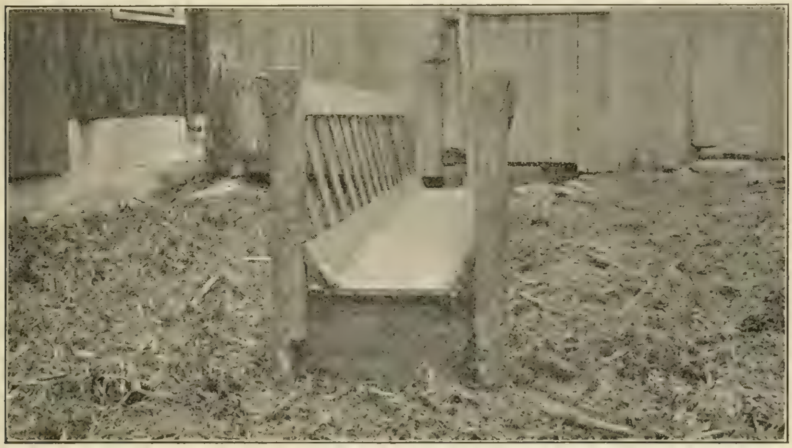

FIG. 16.—*Double feed rack*

FEEDING AND MANAGEMENT

The lambs were received from Chicago on October 29, 1910. They were housed temporarily until November 15th, and were fed mixed hay only. They were then put into their regular pens and the hay continued without grain until November 22d. On November 22d the different lots were started on the grain mixtures they were to receive during the experiment. At first they were fed clover hay and pea-and-oat hay for roughage, and grain once a day at the rate of 8 pounds per day for 58 lambs. Lots A and D were started on silage at the same time. The grain was gradually increased in amount and fed twice a day.

On December 15th it was decided that all lots were in normal condition and taking their rations regularly. Accurate records were begun on that date. All pens were in the same barn, therefore the conditions of light, temperature, and ventilation were the same for all the lambs. Clean salt and fresh water were kept before the lambs at all times. The pens were kept well littered and dry. The general plan of feeding for all pens was, hay and grain twice a day, and silage once a day to pens A and D. For a basis on which to place the feeding, rations were planned for each group. (Tables 1, 2, 3, 4.) These rations were computed for 50 lambs for one day on the basis of 1.1 pounds of dry matter in the roughage per day per head, and 1 pound of dry matter in the grain per day per head. These amounts were the average eaten by the lambs in the Shepard experiment in 1909–10, when on full feed. (Bul. 285.)

The roughage was weighed at intervals of one week for each pen. From these weights the amount of roughage eaten by each pen was determined. The silage was weighed at each feeding time for those pens eating silage. The grain was weighed for each pen at each feeding. All the food was divided as evenly as possible in the feeding racks.

TABLE 1. RATION FOR LOT A, 1910–11. ON BASIS OF FOOD REQUIRED FOR 50 LAMBS FOR 1 DAY

	Lbs. D. M.	Lbs. Pro.	Lbs. C. H.	Lbs. Fat
60 lbs. silage	12.54	.54	6.78	.42
50 " hay	43.50	2.90	20.40	.60
35 " corn	31.20	2.80	23.30	1.50
15 " oats	13.34	1.38	7.10	.62
5 " ajax	4.64	1.10	1.90	.54
Total	105.22	8.72	59.48	3.68

Nutritive ratio, 1:7.8

TABLE 2. RATION FOR LOT B, 1910–11. ON BASIS OF FOOD REQUIRED FOR 50 LAMBS FOR 1 DAY

	Lbs. D. M.	Lbs. Pro.	Lbs. C. H.	Lbs. Fat
65 lbs. hay	56.60	3.85	26.60	.80
35 " corn	31.20	2.80	23.30	1.50
15 " oats	13.34	1.38	7.10	.62
5 " ajax	4.64	1.10	1.90	.54
Total	105.78	9.13	58.90	3.46

Nutritive ratio, 1:7.3

TABLE 3. RATION FOR LOT C, 1910–11. ON BASIS OF FOOD REQUIRED FOR 50 LAMBS FOR 1 DAY

	Lbs. D. M.	Lbs. Pro.	Lbs. C. H.	Lbs. Fat
65 lbs. hay	56.60	3.85	26.60	.80
10 " corn	8.91	.79	6.67	.43
20 " ajax	18.60	4.40	7.60	2.16
20 " gluten	18.36	5.16	8.66	2.20
5 " oats	4.45	.46	2.36	.21
Total	106.92	14.66	51.89	5.80

Nutritive ratio 1:4.4

TABLE 4. RATION FOR LOT D, 1910–11. ON BASIS OF FOOD REQUIRED FOR 50 LAMBS FOR 1 DAY

	Lbs. D. M.	Lbs. Pro.	Lbs. C. H.	Lbs. Fat
60 lbs. silage	12.54	.54	6.78	.42
50 " hay	43.50	2.90	20.40	.60
10 " corn	8.91	.79	6.67	.43
20 " ajax	18.60	4.40	7.60	2.16
20 " gluten	18.36	5.16	8.66	2.20
5 " oats	4.45	.46	2.36	.21
Total	106.36	14.25	52.47	6.02

Nutritive ratio 1:4.6

The feeding of the different lots varied somewhat as to details, but in general the grain was increased and the roughage diminished at approximately the same rate for all lots. The feeding of each lot will now be discussed separately.

Lot A.— On December 15th, Lot A was eating 40 pounds of silage, 82 pounds of roughage consisting of clover hay and pea-and-oat hay, and 30 pounds of grain of the mixture given in the basic ration. (Table 1.) This amounted to slightly more than ½ pound of grain per head per day and approximately 1⅓ pounds of roughage other than silage. The amount of silage was kept constant until the lot was sold. The roughage was gradually increased up to February 15th, when it was diminished to 84 pounds per day. The roughage reached nearly 2 pounds per head per day. The grain ration reached 80 pounds for the lot when on full feed, or 1⅓ pounds per head per day. On January 27th, the pea-and-oat hay gave out and mixed hay was fed instead. Lot A was reduced a little in grain from January 15th to 27th, as were all the lots, because, in the opinion of the feeder, they were being increased a little too fast. The lot was in normal condition at all times and did not seem to be "off feed" at any time. One lamb died in Pen 2, Lot A, on January 27th, but not from "apoplexy." The cause will be discussed at a later point, as will be the gains made by this lot.

Lot B.—This lot was fed the same amount of grain as Lot A. They were fed no silage, being given more hay in place of the silage. The plan of the ration for this lot is given in Table 2. The lambs were started on 108 pounds of hay, clover hay and pea-and-oat hay, increased gradually to 126 pounds of hay by February 15th, then decreased somewhat, reaching 96 pounds per day for the lot of 58 lambs during the last month of the experiment. Lot B seemed to be in good health at all times. No lambs were lost from any of the pens in this lot.

Lot C.— Lot C was fed a narrow grain ration according to the basic ration given for this lot in Table 3. They were fed no silage. The lot contained 86 lambs. The lambs were started on 141 pounds of hay, or a little over 1½ pounds per head per day, and 45 pounds of grain, or about ½ pound of grain per head per day. On February 15th the hay reached approximately 2 pounds per head per day, the lot of 86 lambs being given 174 pounds per day. The hay was reduced until in the last month the amount fed to the 86 lambs per day was 126 pounds, or 1½ pounds per head. The grain fed the last days of the feeding period reached 120 pounds, or approximately 1½ pounds per day for each lamb.

No lambs were lost from this lot until after the experiment was considered closed on April 3d. However, on April 9th one of the lambs was lost from Pen 9. The autopsy showed that this lamb died from inflammation of the small intestine and not from "apoplexy." Otherwise the health of the lot was very good and steady gains were made.

Lot D.— Lot D received a narrow ration with silage as planned in the basic ration for this lot given in Table 4. There were 87 lambs in the lot. They received throughout the experiment 60 pounds of silage per day. The amount of grain fed Lot D was the same as that fed Lot C, being 45 pounds at the beginning and gradually increased to 120 pounds during the last 2 days of the period for the 87 lambs. This lot was fed 114 pounds of hay at the beginning, or 1⅓ pounds per head per day. On February 15th, the total amount fed to the lot reached 151 pounds. During the last month the average amount per day was 113 pounds for the lot, or nearly 1½ pounds per head.

During the experiment 2 lambs in this lot died, one on January 3d, with autopsy negative so far as "apoplexy" was concerned, and the second on January 25th, with autopsy negative. The general health of the lot was as good as that of the others at all times.

AMOUNT AND COST OF FOOD

The feeding period was 110 days, December 15, 1910 to April 3, 1911. Tables 6, 7, 8 and 9 give the quantity of food eaten, the constituents, nutritive ratio, total nutrients, and cost of the ration for each lot. The cost of the different foods was calculated from Table 5.

TABLE 5. PRICE CHARGED FOR FOOD

FOOD	Cost per ton
Mixed hay	$12 00
Pea-and-oat hay	10 00
Corn silage	2 50
Whole corn, 65 cents per bushel	23 21
Whole oats, 45 cents per bushel	28 12
Dried distillers' grains (Ajax)	30 00
Gluten feed	25 00

Cost of grain mixture in wide rations, $1.26 per cwt.
Cost of grain mixture in narrow rations, $1.34 per cwt.

TABLE 6. RATION FED LOT A, DECEMBER 15TH TO APRIL 3D, 110 DAYS

FOOD	Lbs. Pro.	Lbs. C. H.	Lbs. Fat	Cost
8,571 lbs. mixed hay	359.98	3,599.82	111.42	51.43
1,704 " pea-and-oat hay	129.50	707.16	25.56	8.52
4,400 " silage	61.60	624.80	30.80	5.50
5,940 " grain	570.24	3,488.56	287.50	74.84
Total	1,121.32	8,420.34	455.28	140.29

$$\frac{8,420.34+(455.28\times 2\tfrac{1}{4})}{1121.32}=8.4$$

Nutritive ratio = 1 : 8.4
$1121.32+8420.34+(455.28\times 2\tfrac{1}{4}) = 10566.04$ lbs. total nutrients.
$10566.04\div 58 = 182.17$ lbs. total nutrients per lamb.

TABLE 7. RATION FED LOT B, DECEMBER 15TH TO APRIL 3D, 110 DAYS

FOOD	Lbs. Pro.	Lbs. C. H.	Lbs. Fat	Cost
9,941 lbs. mixed hay	417.52	4,175.22	129.23	59.65
2,056 “ pea-and-oat hay	156.26	853.24	30.84	10.28
5,940 “ grain	570.24	3,488.56	287.50	74.84
Total	1,144.02	8,517.02	447.57	144.77

$$\frac{8517.02+(447.57\times 2\frac{1}{4})}{1144.02}=8.3$$

Nutritive ratio = 1 : 8.3.
$1144.02+8517.02+(447.57\times 2\frac{1}{4}) = 10668.07$ lbs. total nutrients.
$10668.07 \div 58 = 183.93$ lbs. total nutrients per lamb.

TABLE 8. RATION FED LOT C, DECEMBER 15TH TO APRIL 3D, 110 DAYS

FOOD	Lbs. Pro.	Lbs. C. H.	Lbs. Fat	Cost
13,655 lbs. mixed hay	573.51	5,735.10	177.52	81.93
2,750 “ pea-and-oat hay	209.00	1,141.25	41.25	13.75
8,890 “ grain	1,746.89	4,087.62	808.10	119.13
Total	2,529.40	10,963.97	1,026.87	214.81

$$\frac{10963.97+(1026.87\times 2\frac{1}{4})}{2529.40}=5.2$$

Nutritive ratio = 1 : 5.2
$2529.40+10963.97+(1026.87\times 2\frac{1}{4}) = 15803.83$ lbs. total nutrients.
$15803.83 \div 86 = 183.77$ lbs. total nutrients per lamb.

TABLE 9. RATION FED LOT D, DECEMBER 15TH TO APRIL 3D, 110 DAYS

FOOD	Lbs. Pro.	Lbs. C. H.	Lbs. Fat	Cost
11,832 lbs. mixed hay	496.94	4,969.44	153.82	70.99
2,458 “ pea-and-oat hay	186.81	1,020.07	36.87	12.29
6,600 “ silage	92.40	937.20	46.20	8.25
8,890 “ grain	1,746.89	4,087.62	808.10	119.13
Total	2,523.04	11,014.33	1,044.99	210.66

$$\frac{11014.33+(1044.99\times 2\frac{1}{4})}{2523.04}=5.3$$

Nutritive ratio = 1 : 5.3
$2523.04+11014.33+(1044.99\times 2\frac{1}{4}) = 15888.60$ lbs. total nutrients.
$15888.60 \div 87 = 182.63$ lbs. total nutrients per lamb.

Table 10. Total gain of lambs, December 15th to April 3d, 110 days

Lot	Number of lambs	Weight, December 15	Average per lamb	Weight, April 3	Average per lamb	Total gain	Average per lamb	Cost of 1 lb. gain
A........	58	3,258	56.2	4,576	78.9	1,318	22.7	.106
B........	58	3,221	55.5	4,132	71.2	911	15.7	.159
C........	86	4,846	56.4	6,472	75.3	1,626	18.9	.132
D........	87	4,983	57.3	7,170	82.4	2,187	25.1	.096

In working out the total nutrients, the fat is multiplied by 2¼ before being added to the protein and carbohydrates in order to put all the constituents on an approximately equal basis.

The nutritive ratio of the rations fed was wider than planned, but the relative difference between the wide and the narrow rations was approximately as planned. (Tables 1, 2, 3, 4.)

The weights of each lot, the average of each lot on December 15th and April 3d, the total gain and the average gain for each lamb, and the cost of 1 pound of gain for each lot, are given in Table 10.

We can now discuss the advantages of narrow rations over wide rations, both with and without succulence in the ration.

NARROW VERSUS WIDE RATIONS

1. *With silage for succulence.*— Under this head Lot D may be compared with Lot A. On December 15th the lambs in Lot D averaged 57.3 pounds per lamb. On April 3d they averaged 82.4 pounds per lamb, a gain per lamb for Lot D of 25.1 pounds. This gain cost 096 per pound with a ration having a nutritive ratio of 1:5.3. (Tables 9, 10.) On December 15th Lot A averaged 56.2 pounds per lamb. On April 3d the average weight was 78.9 pounds per lamb, a gain of 22.7 pounds per lamb for Lot A. The cost per pound of gain in Lot A was .106 with a ration having a nutritive ratio of 1:8.4. (Tables 6, 10.)

From the above we must conclude that the ration with a nutritive ratio of 1:5.3 was more effective than the one with a nutritive ratio of 1:8.4. The amount of total nutrients fed Lot D per lamb for the 110 days was 182.63. (Table 9.) The amount of total nutrients fed Lot A per lamb for 110 days was 182.17. (Table 6.) Therefore the better gain at a less cost per pound, as shown above, must be attributed to the protein in the ration fed Lot D in excess of the protein in the ration fed Lot A.

2. *Without succulence.*— To compare a narrow with a wide ration without succulence, Lot C may be compared with Lot B. The lambs in Lot C averaged 56.4 pounds on December 15th. On April 3d they weighed an average of 75.3 pounds, a gain of 18.9 pounds per lamb. This gain cost .132 per pound with a ration having a nutritive ratio of 1:5.2. (Tables 8, 10.) Lot B averaged 55.5 pounds per lamb on December 15th, and 71.2 pounds per lamb on April 3d, a gain of 15.7 pounds per lamb. This gain cost .159 per pound with a ration having a nutritive ratio of 1:8.3. (Tables 7, 10.)

Again the better and cheaper gain was made with the narrow ration. Lot C was fed 183.77 pounds of total nutrients per lamb in the 110 days; Lot B, 183.93 pounds of total nutrients in the same time. Therefore, as with Lot D above, the better and cheaper gains must have been due largely to the greater amount of protein in the ration fed Lot C.

THE VALUE OF SUCCULENCE IN THE RATION

Two good comparisons are possible to show the value of succulence in the ration. Lot A was fed a wide ration with silage for succulent food, and Lot B a wide ration without silage. Lot D was fed a narrow ration with silage, and Lot C a narrow ration without silage.

Comparing Lot A with Lot B, we see that the lambs in Lot A made an average gain of 22.7 pounds at a cost of .106 per pound. The lambs in Lot B made an average gain of 15.7 pounds at a cost of .159 per pound. The nutritive ratio of Lot A's ration was 1:8.4; that of Lot B was 1:8.3. Lot A was fed 182.17 pounds of total nutrients per lamb in the 110 days; Lot B, 183.93 pounds. (Tables 6, 7, 10.)

Comparing Lot D with Lot C, the result is the same. Lot D received a narrow ration with silage. The average gain for Lot D was 25.1 pounds at a cost of .096 per pound. Lot C received a narrow ration without silage. The average gain for the lambs in Lot C was 18.9 pounds at a cost of .132 per pound. The nutritive ratio of Lot D's ration was 1:5.3, and that of Lot C was 1:5.2. Lot D received 182.63 pounds of total nutrients per lamb in 110 days, and Lot C 183.77 pounds. (Tables 8, 9, 10.)

From these comparisons we must conclude that the silage was a great advantage, both in the wide and in the narrow ration. The amount of total nutrients fed per lamb was practically the same in every case. The advantage was clearly with the narrow ration with silage over the narrow ration without silage, and with the wide ration with silage over the wide ration without silage.

NOTES ON "APOPLEXY"

No cases of "apoplexy" occurred in the Cornell Experiment from over-feeding or from the feeding of narrow rations, either during the course of the regular experiment, December 15th to April 3d, or with the lambs kept up to May 8, 1911, for further data concerning the cause of "apoplexy."

The lambs were all weighed April 3d, and this date marked the close of the regular experiment, as has been shown. From April 3d to April 8th the lambs were fed as usual in their several pens. On April 8th, 275 lambs were selected for shipment. This left 14 ewes and 27 wethers of a rather poorer quality than those selected for shipment. It was decided to feed these lambs about a month longer for further observations on the cause of "apoplexy."

The ewes were fed as one lot for a check and the wethers as the experimental lot. Both lots were fed the same narrow grain ration as fed to Lots B and C during the regular experimental period. (Tables 3, 4.) They were fed no silage after the first three days, being given mixed hay alone for roughage. In the pen of ewes each ewe had a single feeding place in the rack, but the space in the pen was large enough for more exercise than they had had formerly. With the wethers, however, there were more feeding places in the rack at all times than there were lambs, so that each lamb could gorge himself if he wished. The 14 ewes were fed 10 pounds of grain per day up to May 8th, when this special experiment closed. This amount was what they would eat up clean. The conditions for them were the same as they had been since December 15th, except that the lambs had more exercising area.

The 27 wethers were started April 8th on 10 pounds of grain, and on the 9th this amount was doubled. On April 15th five wethers were taken out and slaughtered, but the amount of grain was not decreased. On April 24th seven more wethers were slaughtered and the same amount of grain continued. The wethers now began to leave grain, which was removed at each feeding time when fresh grain was put in. On May 1st seven more were slaughtered and on May 8th those remaining were slaughtered. The grain was kept at 20 pounds regardless of the number of wethers, and the amount uneaten was removed before the next feeding. Thus, every lamb was allowed to eat all he possibly could at any time from a narrow ration.

No lamb was lost in either lot due to "apoplexy." One wether died on April 11th due to other causes than "apoplexy," as will be shown in the report of the autopsy in this case.

From this supplementary trial and the regular experiment, the conclusion is that neither over-feeding nor the feeding of rations with a nutritive ratio of 1:5 may be looked on as a cause of "apoplexy." The negative conclusion from the experiment of 1910–11 agrees with the results in the preliminary trial at Mr. Shepard's farm so far as the feeding of narrow rations is concerned. The results from over-feeding do not check so well with the results obtained there, in that losses from "apoplexy" were suffered from over-feeding at Mr. Shepard's farm. It may be said, however, in explanation of this last point, that the lambs given an opportunity to over-feed in the Cornell Experiment were not in so good a condition as those in the previous experiment. The conclusion from both years is clear that if care is taken in keeping the pens full the loss from over-feeding will be reduced to a minimum.

Altogether, from December 15, 1910 to May 8, 1911, 5 lambs were lost from the number under experiment. The following report was received from the New York State Veterinary College covering their autopsies:*

TABLE 11. AUTOPSIES OF WINTER LAMBS

Date of examination of lambs	Autopsy
January 5, 1911	"Autopsy negative."
" 25, 1911	" Lamb noticed sick at night, found dead in the morning. Intestines dark. Liver friable, small whitish spots 2–5 mm. diameter."
" 27, 1911	"Autopsy negative." (Autopsy by Dr. J. N. Frost, New York State Veterinary College.)
April 7, 1911	" Inflammation of small intestines."
" 11, 1911	" Congestion of the mucous membrane of the cecum."

" In most of these animals there was found a congestion or inflammation of the intestines. It is probable that most of them died from intestinal trouble, either catarrhal inflammation or hemorrhagic inflammation of the small intestines or cecum."

SUMMARY OF OBSERVATIONS AT CORNELL UNIVERSITY, 1910–11

Cause of "apoplexy"

Nothing can be added to the summary given on page 46, Bulletin 285, as to the cause of "apoplexy." All the observations made in 1910–11 led to negative conclusions, since no losses were suffered from this disease. The results of the feeding trials in both years show that apoplexy is not caused from feeding rations as narrow as 1:5. As for over-feeding, it is advised to have care in this regard and to keep the pens full, with only one feeding place in the rack for each lamb.

Amounts of protein to feed

The results at the Cornell Station bear out the results at the Shepard farm. Rations with a nutritive ratio of 1:5.3 gave relatively better results than wider rations. The wider ration with silage gave better results than the narrow ration without silage, but this was evidently due to the silage since the wide ration without silage gave the poorest results of all. A ration of 1:5 is advised as a good standard for this class of feeding stock.

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* Reported by Dr. D. H. Udall, New York State Veterinary College, Ithaca, N.Y.

Value of succulence

The results of this experiment show that silage is of great advantage in the ration, and should be used when obtainable. The cheapest gains were made with a narrow ration with silage. The next cheapest gains were made with a wide ration with silage, the succulence of the ration overcoming the tendency to produce lower gains with less protein in the ration. The most economical ration was that with a nutritive ratio of 1:5.3, with silage for succulence. This ration produced the largest gains at the lowest cost per pound of gain.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

THE FOLLOWING BULLETINS ARE AVAILABLE FOR DISTRIBUTION TO THOSE RESIDENTS OF NEW YORK STATE WHO MAY DESIRE THEM

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154 Table for Computing Rations for Farm Animals.
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219 Diseases of Ginseng.
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281 Butter Moisture-Tests.
282 Seven Methods of Feeding Young Chickens.
283 The Control of Insect Pests and Plant Diseases.
284 Labor-Saving Poultry Appliances.
285 Cause of "Apoplexy" in Winter-Fed Lambs.
286 Snow White Linden Moth.
288 Spray Injury Induced by Lime-Sulfur Preparations.
289 Lime-Sulfur as a Summer Spray.
291 The Apple Red Bug.
292 Cauliflower and Brussels Sprouts on Long Island.
293 The Black Rot Disease of Grapes.
294 A Heretofore Unnoted Benefit from the Growth of Legumes.
295 An Agricultural Survey of Tompkins County.
298 The Packing of Apples in Boxes.
300 The Cabbage Aphis.
301 Sweet Pea Studies: I.
302 Notes from the Agricultural Survey of Tompkins County.
303 The Cell Content of Milk.
304 Substitutes for Skimmed Milk in Raising Calves.

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CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Horticulture

CLASSIFICATION OF THE PEONY

Fourth Report

Ville de Nancy

BY LEON D. BATCHELOR

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

The field at the Cottage Gardens nurseries where the committee studied synonymy for the past two years

INTRODUCTORY NOTE

As chairman of the committee on nomenclature of the American Peony Society and also the person in general charge of the cooperative peony studies at Cornell undertaken by the Society and the Department of Horticulture, the writer is pleased to present to peony lovers a fourth report on the progress of this investigation.

This report, like the last published in May, 1910, and reprinted through the financial aid of an interested amateur peony grower, is the work of Mr. Leon D. Batchelor, now professor of horticulture in Utah State Agricultural College, assisted as before by Messrs. Farr and Dauphin. While the field work involves technical skill and discriminating ability of a high order, the work of classifying and editing the field notes is also very considerable. In this as well as in the field work, Mr. Batchelor has rendered excellent service. Such assistance as he has received has been gratefully acknowledged. The whole study has been truly cooperative. It is now approaching the final stages when the important question of eliminating large numbers of mediocre varieties should receive the thoughtful consideration of the Society. Another important step should be the establishment of a registry board to pass upon the merits of new varieties before these are officially recognized. Such a step would do much toward suppressing the introduction of many kinds of little or no value except in the eyes of the originator.

John Craig.

CONTENTS

PAGE
Introductory Note 53
Progress of the Study 55
Well Recommended Varieties of Peonies........................ 57
Additional Notes and Corrections to Descriptions in Bulletin 278... 59
List of Synonyms.. 62
Description of Varieties....................................... 69
Index to Variety Descriptions 155

CLASSIFICATION OF THE PEONY

Leon D. Batchelor

PROGRESS OF THE STUDY

During the season of 1910 the work of peony classification was continued as outlined in Bulletin 278. Many additional varieties were identified, and a large number of synonyms were established.

There are still a few prominent varieties missing from this classification which could not be found in the nurseries visited and which do not occur in the Cornell trial plots. The classification at present, however, contains at least ninety-five per cent of the important commercial varieties.

The commercial collections, which were started in the fall of 1907, produced an abundance of typical blooms the past season. The entire plot was carefully gone over and each firm's collections checked up as regards identity of varieties, synonyms, etc.

At the end of the season a report was sent to each donator stating the findings of the committee.

Studies were also made in the nurseries of several firms in the eastern part of the country.

It was the intention of the writer and Professor Craig to draw up an identification key to this entire classification. During the rush of the blooming season, however, it was impossible to construct such a key and at the same time inspect the vast number of varieties necessary to complete the classification and synonym list. It was found impracticable to construct such a key after the blooming season was over by the descriptions alone, without the aid of the blooms themselves for comparison. In fact, the peony is so variable under different conditions, that the practicability of the identification key may itself be questionable. It should be thoroughly tried out before any key is incorporated in the final report.

During the entire work the writer has been impressed with the large number of only medium varieties which are being continually originated and propagated by the trade. It is probably a conservative statement to say that the peony interests of the country would be better off if about seventy-five per cent of the varieties were destroyed and future propagation made from the remaining twenty-five per cent of superior varieties. It is not that these seventy-five per cent of the varieties are positively unattractive; far from it. But the remaining twenty-five per cent fill every purpose and have many more virtues than the only medium to inferior sorts. By discarding the mediocre or poor sorts and selling only the more desirable varieties the customers would be even more infatuated with this beautiful flower, and a more extensive and higher class trade would be built up, to the benefit of all concerned.

It would also seem highly desirable before a new variety is brought into the trade to have it shown at the American Peony Society's annual exhibit and passed upon by a standing committee of the society appointed for this purpose. If the new sort proves to be something exceptionally fine, the society's stamp of approval and commendation should be a valuable asset in the sale of the novelty. When a new variety is not at least equal if not superior to the similar varieties in the trade, the originator could hardly expect the support of a society already overburdened with too many sorts.

Permanent plots have been started on the Experiment Station grounds for the culture of varieties of which the identity is reasonably certain. As other varieties are classified, or new ones appear in the trade from time to time, they should be added to this planting, that an authentic, complete, permanent collection may become established for the advancement of the peony interests of the country.

Throughout the entire season Mr. Jos. Dauphin and Mr. B. H. Farr were in almost constant consultation with the writer in identifying varieties and establishing synonyms. A great deal of credit is due these gentlemen for their tireless effort and hearty cooperation with the Experiment Station in conducting this work. In fact, if the writer had been denied the aid of Mr. Dauphin's vast knowledge of varieties, and Mr. Farr's constant interest and self-sacrificing spirit, the completion of the work would hardly have been possible.

Acknowledgment is also due the several members of the American Peony Society, who have so kindly cooperated in answering many questions concerning the identity of varieties. Prof. A. P. Saunders has very materially aided in the work by his valuable suggestions and accurate work in proofreading. The American Peony Society is also greatly indebted to Professor Craig for his constant interest and wise guidance in the conduct of this work.

VARIETIES FOR CUT FLOWERS AND LANDSCAPE OR BORDER PLANTING

The committee has frequently been called upon by amateur growers to recommend varieties of peonies for different purposes. We therefore include the following list of very desirable sorts which include some of the most valuable varieties in the trade:

WELL RECOMMENDED VARIETIES OF PEONIES

White

For Cut Flowers

Festiva Maxima
Couronne d'Or
Duchesse de Nemours
Baroness Schroeder
Albâtre
Alba Sulfurea
Madame Crousse
Madame Calot
Madame de Vernéville
Boule de Neige
Avalanche
Duc de Wellington

For Landscape

Octavie Demay
Marie Jacquin
Baroness Schroeder
Albâtre
Duchesse de Nemours
Alice de Julvécourt
Madame de Vernéville
Festiva
Marie Lemoine
Couronne d'Or
Madame Bréon
La Rosière
Albiflora the Bride
Avalanche
Festiva Maxima

Pale Pink

For Cut Flowers

Achille
Albert Crousse
Dorchester
Floral Treasure
La Perle
Madame Lemoine
Marguerite Gérard
Marie d'Hour
Miss Salway
Mademoiselle Léonie Calot
Madame Émile Gallé
Venus

For Landscape

Achille
Eugène Verdier
Eugénie Verdier
Dorchester
Floral Treasure
Marie d'Hour
Triomphe de l'Exposition de Lille
Venus
La Perle
Marie Crousse
James Kelway

Pink and White

For Cut Flowers

Gloire de Charles Gombault
La Tulipe
Jeanne d'Arc

For Landscape

Umbellata Rosea
Golden Harvest
Madame Costé
Madame de Vatry
Thérèse
Princess Beatrice
Beauté Française
Philomèle

Deep Pink

For Cut Flowers

Madame Ducel
Lamartine
Monsieur Jules Elie
Livingstone
Monsieur Boucharlat aîné
Souvenir de l'Exposition Universelle
Madame Lebon
Général Bertrand
Modeste Guérin
Edulis Superba
Alexandre Dumas
Madame Muyssart
Kelway's Queen

For Landscape

Madame Ducel
Livingstone
Monsieur Boucharlat aîné
Souvenir de l'Exposition Universelle
Madame Lebon
Général Bertrand
Modeste Guérin
Edulis Superba
Madame Muyssart
Alexandre Dumas
Modèle de Perfection

Red

For Cut Flowers

Félix Crousse
Louis Van Houtte
Henry Demay

For Landscape

Fulgida
Félix Crousse
Augustin d'Hour
Louis Van Houtte
De Candolle
Henry Demay
Dr. Caillot

Deep Red

For Cut Flowers

Delachei
Prince de Talindyke*
Constant Devred
Nigricans
Madame Becquet
Pierre Dessert
Rubra Superba

For Landscape

Delachei
Monsieur Martin Cahuzac
Stanley (Kelway)
Raphael
Madame Becquet
Adolphe Rousseau

---

*I think Prince de Talindyke should not be recommended. The variety has only a local existence, and is, I believe, a miswriting of Prince de Salm Dyck or a kind that had lost its name. The European lists contain no Prince de Talindyke, and we should find out what its right name is before recommending it.

A. P. Saunders.

While the origin of Prince de Talindyke is unknown, and it is possible it may exist under another name, it is a fact that no duplicate of it has been found in the Cornell plot, nor in any other collection visited by the Committee. In freedom of bloom, length of stem, and durability, when shipped it is not surpassed by any other dark crimson. In color and habit of growth, it differs from Prince de Salm Dyck.

B. H. Farr.

ADDITIONAL NOTES AND CORRECTIONS TO DESCRIPTIONS IN BULLETIN 278

Général Bertrand, page 231. "Rosetta" should be added as a synonym of this variety.

La Coquette, page 232. Should be spelled thus, rather than as noted in former bulletin.

Delachei, page 233. "Emperor William" should be added as a synonym of this variety, and the name should be "Delachei" instead of "Delache."

Monsieur Dupont, page 233. "Merveilleuse" should be added as a synonym of this variety.

Rubens, page 239. Should be classed as a *medium* variety rather than *inferior.*

Charles Gosselin, page 241. This is not a true synonym of "Anemoneflora rubra." The varieties were simply mixed in the plots.

Petite Renée, page 242. Under remarks: it is the opinion of the committee that "Hinodesekai" is not identical with the above sort.

Madame de Bollemont, page 243. Should be spelled thus, rather than as noted in above bulletin.

Armand Rousseau, page 243. Should be spelled thus, rather than as noted in above bulletin.

Edouard André, page 243. Correct to a medium variety, with good landscape qualities; medium bloomer, with a medium stem.

Thurlow's Double Red, page 244. This so-called variety seems to be identical with "Dr. Caillot" (Verdier).

Fulgida, page 245. "Brennus" should be added as a synonym of this variety.

Grandiflora Nivea Plena, page 248. Should be *early* rather than *midseason.*

Lutea Plenissima, page 249. "Victor Durufle" should be added as a synonym.

Duchesse de Nemours, page 249. "Diamond" should be added as a synonym.

Alexandre Dumas, page 252. Should be spelled thus, rather than as it occurs in the aforementioned publication. "Rosamond" should be added as a synonym.

Victoire Lemon, page 253. "Anna" and "Phrynnée" should be added as synonyms.

Philomèle, page 254. "Miss Brice" should be added as a synonym.

[The plants seen under the name "Miss Brice" are Philomèle; but it is not at all certain these were the same as the original Miss Brice, introduced by Kelway as one of their seedlings, and it is very likely that the true Miss Brice will be found to be a distinct variety and not a synonym. This is an example of many similar cases in which a name may be mistakenly classed as a synonym, because the plant we found so labeled may not be correct. It is as if we should come across a pink peony labelled Festiva Maxima that was identical with Edulis Superba, and should conclude that Festiva Maxima was a synonym of Edulis Superba. B. H. Farr.]

Prolifera Tricolor, page 254. "Prolifera" should be added as a synonym.

Duc de Cases, page 256. "Comte de Cayes" should be added as a synonym, although very likely a mere error in spelling.

Edulis Superba, page 257. Under synonyms: information on the identity of "Sainfoin" and "Glorie de Douai" indicates that these sorts are distinct varieties, even though they were merely "Edulis Superba" falsely labeled in the Cornell plots. (See note on "Miss Brice.")

Baron James de Rothschild, page 259. "Lord Roberts" should be added as a synonym.

Carnea Elegans, page 262. Should read, originated by Calot.

Good variety rather than *poor.*

Strong variety rather than *weak.*

Medium variety rather than *dwarf.*

Free rather than *medium* bloomer.

Princess Maud, page 263. *Remarks*—Very similar to "Duc de Wellington."

Dr. Bretonneau, (Verdier), page 263. The following so-called sorts should be added as synonyms: "Rosea Superba" (this also is oftener a synonym of "Modeste Guérin"), "Rosea Plenissima Superba," "Nell Gwynn," "Marquis Ito," "Madame Modeste," "Active," "Fairy Queen," "Isabella Karlitzky," "Lady Leonora," "Reevesiana," "Frina," and "Thisbé."

Duchesse d'Orleans, page 267. "Plena Variegata" should be added as a synonym.

Decaisne, page 269. There is some doubt as to the identity of this variety.

André Lauries, page 271. This variety should be known as "Fragrans," as it was introduced from China, in 1805, by Sir Joseph Banks under the latter name. The following synonyms should be added: "American Beauty," "Edulis," "Edulis Fragrans," "Chinensis Rubra," "Fragrantissima," "Mons. Charles Leveque" (here a variety under the name Mons. Charles is meant, since the variety Charles Leveque, introduced from Holland, is a synonym of Mlle. Léonie Calot.— B. H. Farr), and "Rosea Plenissima."

Madame Émile Lemoine, page 273. Added note: prominent carmine flecks occur on the central petals.

Dr. Caillot, page 274. "Thurlow's Double Red" should be added as a synonym.

La Brune, page 276. Should be described as loose semi-double rather than semi-rose type; in fact, it is nearly single in some cases.

Empereur Nicolas, page 278. *Remarks* — There is another "Emperor Nicolas" in the trade, of a dark purple garnet color 4 (165).

Mademoiselle Léonie Calot, page 280. "Monsieur Charles Leveque" should be added as a synonym. The latter variety has also occurred as a synonym of "André Lauries."

Delicatissima, page 284.

Description in detail — Green flecks and a cream white color are characteristics which frequently distinguish the blooms of this variety.

Remarks — "Delicatissima" usually blooms about two days later than "Floral Treasure," has a more erect habit, has a small crown, and is a tint darker when closely compared with "Floral Treasure."

Globosa, page 286. *Description in brief* should read: "Medium to large, fading to cream white."

Carnea Humei, page 287. Should be described as *early,* rather than *very late* season. (The correct name is *Humei Carnea.*)

Lamartine, page 288. Should be classed a *rose type* bloom, uniform color throughout, rather than "guards and collar fading rose white." [There is another Lamartine. Introduced by Lemoine in 1908. Deep violet rose with wide silvery border. Very tall. Rose type. — B. H. Farr.]

"Gigantea" and "Habid" should be added as synonyms.

Livingston, page 289. "Adele" should be added as a synonym.

Maréchal Vaillant, page 293. "Lee's Grandiflora" should be added as a synonym.

Eugène Verdier, page 293. Should be described as very erect habit.

Lafayette, page 294. Should be, originated by Dessert, 1904. Description, rose bloom, silver tipped.

INDEX TO VARIETY DESCRIPTION

"Emma" should be added, page 257.

"Madame Bréon" should be added, page 261.

DESCRIPTION OF VARIETIES

In the following descriptions the varieties of peonies are classified into eight groups: Single, Japanese, Anemone, Semi-double, Crown, Bomb, Semi-rose, and Rose. For a discussion of the above classification see Bulletin 278, page 227.

EXPLANATORY REMARKS

A slightly different method of indexing has been used this year, in that the varieties are arranged alphabetically as they are commonly spoken of; whereas in previous publications, in case of the presence of a surname the variety was listed under this rather than the given name. This method has caused some confusion; however, as it was in use when the writer took up the work it was followed until this publication, when a more simple method was adopted. For example: Alba Sulfurea is found under "A," Georgiana Shaylor under "G," whereas they would formerly have been classified under "S."

The following index includes all varieties classified in Bulletins 259 and 278 as well as this publication. The descriptions are made in a little more detail than previously, especially concerning the plant habit and general adaptability of the variety.

A discussion of the method of describing varieties and color comparisons will be found on pages 223–227 of Bulletin 278.

The varieties which are described as blooming in clusters should be disbudded when grown for cut blooms.

LIST OF SYNONYMS

ACTIVE.

This so-called variety is a synonym of "Dr. Bretonneau," originated by Verdier in 1854. "Active" appeared suddenly in the trade within recent years from an unknown source.

See "Dr. Bretonneau," Bulletin 278, page 263.

ADELE.

This so-called variety, not found very widely in the trade, is a synonym of "Livingston," originated by Crousse, 1879. For a description see Bulletin 278, page 289.

ALBA MAXIMA.

This is a synonym of the well known variety "Festiva Maxima," originated by Miellez in 1851. "Alba Maxima" has been started on its masquerade since 1900.

AMERICAN BEAUTY.

This so-called variety is a synonym of "Fragrans," introduced from China by Sir Joseph Banks in 1805, since which it has masqueraded under many different names. See page 63.

ANNA.

This so-called variety which has come very recently into the trade is a synonym of "Victoire Lemon," originated by Miellez, 1858.

For description see Bulletin 278, page 253.

BRENNUS.

This so-called variety is a synonym of "Fulgida," originated by Parmentier in 1850. "Brennus" seems to have come into the trade from unknown sources within recent years. For a description of "Fulgida" see Bulletin 278, page 245.

CHINENSIS RUBRA.

This so-called variety is a synonym of "Fragrans," introduced from China by Sir Joseph Banks in 1805, since which it has masqueraded under many different names. See below.

COMTE DE CAYES.

This so-called variety is a synonym of the well known variety "Duc de Cazes," originated by Guerin in 1850. "Comte de Cayes" started on its career from an American nursery within recent years.

DIAMOND.

This so-called variety, which has come into the trade since 1900, is a synonym of "Duchesse de Nemours" (Calot 1856).

For a description see Bulletin 278, page 249.

DUKE OF CLARENCE.

This so-called variety seems to be a synonym of "Princess Beatrice," originated by Kelway in 1886. See Bulletin 278, page 250.

EDULIS.

This so-called variety is a synonym of "Fragrans," introduced from China by Sir Joseph Banks in 1805, since which it has masqueraded under many different names. See below.

EDULIS FRAGRANS.

This so-called variety is a synonym of "Fragrans," introduced from China by Sir Joseph Banks in 1805, since which it has masqueraded under many different names. See below.

EMPEROR WILLIAM.

It is doubtful if there is a true variety of this name, as there is no record of any such being originated. As it has occurred in the Cornell plots it has been really "Louis Van Houtte" in one case and "Delachei" in the other.

FAIRY QUEEN.

This so-called variety was supposed to have been originated by Terry, but wherever it has been seen by the committee it has proved to be "Dr. Bretonneau" (Verdier).

FRAGRANS.

Correction to Bulletin 278, page 271. The above variety is wrongly described as "André Lauries" in the aforementioned publication. For a correct description of "André Lauries" see page 152. These two varieties have been somewhat confused, and "Fragrans" is more often sold as "André Lauries" than otherwise.

"Fragrans" was introduced from China by Sir Joseph Banks in 1805, while "André Lauries" was originated by Crousse in 1881.

Synonym — "Fragrans" is also found in the trade under the following names: "American Beauty," "Edulis," "Edulis Fragrans," "Chinensis Rubra," "Fragrantissima," "Monsieur Charles Leveque," and "Rosea Plenissima." These names should be stricken from the trade as they are synonyms of "Fragrans" pure and simple.

FRAGRANTISSIMA.

This so-called variety is a synonym of "Fragrans," introduced from China by Sir Joseph Banks in 1805, since which it has masqueraded under many different names. See page 63.

FRINA.

This so-called variety, which has recently appeared in the trade from European nurseries, is a synonym of "Dr. Bretonneau" (Verdier).

For a description see Bulletin 278, page 263.

GALENE.

Note: Same as "Stewart's America."

GIGANTEA.

This so-called variety is a synonym of the well known variety "Lamartine," originated by Calot in 1860. "Gigantea" has suddenly appeared in the trade from unknown sources since 1900.

"Dr. Bretonneau" (Verdier) has also been found masquerading under the name of "Gigantea."

HABID.

This so-called variety is a synonym of the well known variety "Lamartine," originated by Calot in 1860. "Habid" has suddenly appeared in the trade from unknown sources since 1900.

ISABELLA KARLITZKY.

"Dr. Bretonneau" (Verdier) often appears in the trade under the above name. The true variety is described in Bulletin 259, page 142.

LADY LEONORA.

This so-called variety is a synonym of "Dr. Bretonneau" (Verdier), "Lady Leonora Bramwell," etc.

See "Dr. Bretonneau," Bulletin 278, page 263.

LEE'S GRANDIFLORA.

This so-called variety is a synonym of "Maréchal Vaillant," originated by Calot in 1867. "Lee's Grandiflora" came to public notice very recently.

LORD ROBERTS.

This so-called variety is a synonym of "Baron James de Rothschild," originated by Guerin in 1850. "Lord Roberts" suddenly appeared in the trade from unknown sources about 1900.

MADAME MODESTE.

This so-called variety is a synonym of "Dr. Bretonneau," originated by Verdier in 1854. "Madame Modeste" appeared suddenly in the trade within recent years from an unknown source.

See "Dr. Bretonneau," Bulletin 278, page 263.

MARIE STUART.

A variety occurring in the Cornell plots under this name is identical with "Venus." There is a "Marie Stuart" (Calot), however, which is entirely unlike the above. See Bulletin 278, page 255.

MARQUIS D'LORY.

This so-called variety is a synonym of "Virginie," originated by Calot in 1856; it began its masquerade as "Marquis d'Lory" since 1900.

MARQUIS ITO.

This so-called variety is a synonym of "Dr. Bretonneau," originated by Verdier in 1854. "Marquis Ito" appeared suddenly in the trade within recent years from an unknown source.

See "Dr. Bretonneau," Bulletin 278, page 263.

MERVEILLEUSE.

This so-called variety, which has appeared in the trade since 1900, has proved to be a synonym of "Monsieur Dupont," originated by Calot in 1872.

For a description see Bulletin 278, page 233.

MISS BRICE.

This so-called variety, which was supposed to have been originated by Kelway in 1888, has proved to be "Philomèle," originated by Calot in 1861.

MONSIEUR CHARLES LEVEQUE.

This so-called variety, sent to the Cornell plots from Europe, proved to be a synonym of "Mademoiselle Léonie Calot," originated by Calot in 1861.

MONSIEUR DOFFREY.

This so-called variety has come into the trade within recent years. Is a synonym of "Fragrans."

See "Fragrans," page 63.

MRS. SAGUTE.

This so-called variety of unknown origin is a synonym of "Madame Ducel," originated by Mechin in 1880. For a description see Bulletin 259, page 132.

NELL GWYNN.

This so-called variety is a synonym of "Dr. Bretonneau," originated by Verdier in 1854. "Nell Gwynn" appeared suddenly in the trade within recent years from an unknown source.

See "Dr. Bretonneau" (Verdier), Bulletin 278, page 263

PAPILIONACEA.

This so-called variety is identical with "Whitleyi" and should be known as such. "Whitleyi" was found in the trade as early as 1820 and was supposed to have been originated by Whitley in 1808; while "Papilionacea" has come forth since 1900. For a description of "Whitleyi" See page 106.

PEARL.

This so-called variety has proved identical with "Venus."

PERFECTION.

(This is not Richardson's)

This so-called variety is a synonym of "Madame Courant," originated by Courant in 1850.

For a description see page 80.

PHOENICA VARIEGATA.

This so-called variety, which came into the trade from unknown sources since 1900, is a synonym of "Madame Courant," originated by Courant in 1850. For a description see page 80.

PHRYNNÉE.

This so-called variety seems to be a synonym of "Victoire Lemon," originated by Miellez, 1858.

For a description, see Bulletin 278, page 253.

PLENA VARIEGATA.

This so-called variety has appeared in the American trade within recent years; wherever it has been seen it has proved to be a synonym of "Duchesse d'Orleans."

For a description see Bulletin 278, page 267.

PRINCESS MAY.

This so-called variety has proved identical with "Venus," which was in the trade about twelve years before it appeared as "Princess May."

PROLIFERA.

This is a synonym of, and should be known as, "Prolifera Tricolor," originated by Lemon in 1825. For a description of the variety see page 254, Bulletin 278.

QUEEN ESTHER.

This so-called variety is a synonym of "Madame Costé."

For a description see page 109.

QUEEN VICTORIA.

This well known variety has been in the trade since 1830 and everywhere it has appeared it has proved identical with "Whitleyi," another well known sort originated by Whitley in 1808. It should be known only as "Whitleyi," and "Queen Victoria" and its many other synonyms stricken from the trade lists. For a description of "Whitleyi" see page 106.

Note: There is, however, a variety "Queen Victoria" originated by Kelway within recent years. See page 93.

REEVESIANA.

If there is a genuine variety by this name, it is not known to the committee. Wherever it has been seen by the committee it has proved to be "Dr. Bretonneau" (Verdier).

ROSA BARRY.

This so-called variety, which was supposed to have originated in Ellwanger & Barry's nurseries, has proved to be "Whitleyi."

For a description of "Whitleyi" see page 106.

ROSAMOND.

It is very doubtful if there is a true variety of peony by this name. Wherever it has been seen it has been a synonym of "Alexandre Dumas."

For a description see Bulletin 278, page 252.

ROSEA PLENISSIMA.

This so-called variety is a synonym of "Fragrans," introduced from China by Sir Joseph Banks in 1805, since which it has masqueraded under many different names. See page 63.

ROSEA PLENISSIMA SUPERBA.

This so-called variety is a synonym of "Dr. Bretonneau," originated by Verdier in 1854. "Rosea Plenissima Superba" appeared suddenly in the trade within recent years from an unknown source.

See "Dr. Bretonneau" (Verdier), Bulletin 278, page 263.

ROSEA SUPERBA.

This so-called variety is a synonym of "Dr. Bretonneau," originated by Verdier in 1854. "Rosea Superba" appeared suddenly in the trade within recent years from an unknown source.

See "Dr. Bretonneau" (Verdier), Bulletin 278, page 263.

Note: The above should not be confused with "Dr. Bretonneau," originated by Guerin in 1850. See Bulletin 278, page 280.

"Modeste Guérin" has also been found under the assumed name of "Rosea Superba."

ROSETTA.

This so-called variety appeared in the American trade within recent years. It is, however, a synonym of "Général Bertrand," originated by Guerin in 1845.

For a description see Bulletin 278, page 231.

SNOW WHITE.

This is a synonym of, and should be known as, "Whitleyi," one of the oldest peonies in the trade. "Snow White" began its masquerade within recent years.

For a description of "Whitleyi" see page 106.

STEWART'S AMERICA.

This so-called variety is one of the many synonyms for "Whitleyi," which has been in the trade since 1808. "Stewart's America" appeared in the trade from unknown sources within recent years.

Correction to Bulletin 259. The above was described as a true variety in the aforementioned publication before it was known to be a synonym of "Whitleyi."

THISBÉ.

This so-called variety, which has been catalogued by both American and European growers, has proved to be "Dr. Bretonneau" (Verdier). "Thisbé" should be stricken from the trade, with the several other synonyms of this well known sort.

For a description of "Dr. Bretonneau" (Verdier) see Bulletin 278, page 263.

THURLOW'S DOUBLE RED.

Although this variety was supposed to have originated in Mr. T. C. Thurlow's nursery, it seems identical with "Dr. Caillot," originated by Verdier in 1856. The committee is of the opinion that it can safely be considered a synonym of "Dr. Caillot."

Note: The plants on which judgment was passed were sent to the Cornell plots by Mr. Thurlow in 1907.

Correction to Bulletin 278. The above was described in this publication before it was known to be a synonym.

TRIUMPHANS GANDAVENSIS.

Synonym — This so-called variety is, without doubt, "Alice de Julvécourt" and should be known as such. "Alice de Julvécourt" was originated by Pele in 1857, while Triumphans Gandavensis suddenly appeared from unknown sources a few years later. For "Alice de Julvécourt" see page 103.

Correction to Bulletin 259. This sort was wrongly described under the above name in Bulletin 259 before it was known to be a synonym.

VICTOR DURUFLE.

It is very doubtful if there is a true variety by this name; wherever it has been observed, it has proved to be identical with "Lutea Plenissima," and should therefore be known only as a synonym of this well known variety. For a description of "Lutea Plenissima" see Bulletin 278, page 249.

ADDITIONAL SYNONYMS

Noted in Bulletin 278

	PAGE		PAGE
Acanum	255	Lemoine	289
Bridesmaid	242	Lilacina Superba	258
Canista	266	Maiden's Blush	254
Cyntherii	247	Mamie Cutler	256
Delia	256	Mons. Andre	251
Early Rose	256	Pizano	258
Edulis Odorata	256	Rosa Lilacina	259
Emma	257	Sailet	241
Glorie de Deumai	258	Sainfoin	259
Grandiflora Alba Laciniata	248	Superba	260
Gretchen	253	Sylvanus	260
Hector	258	Thorbeckii	292
Jussier	245	Water Lily	242

DESCRIPTION OF VARIETIES

SINGLE TYPE

White

COUNTESS OF WARWICK.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom single. Color (total effect) 2 (7) lilac white. Fragrance unpleasant X. Blooming time early. Very large size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, very strong, green to reddish green. Blooming habit medium. Buds borne in clusters. Foliage well furnished, medium to light green, medium size; veins green.

Commercial value — For cut bloom poor; landscape value good.

Remarks — Similar to "Flag of Truce" but heavier stem, slightly taller, coarser foliage, and more open bloom. "The Queen" has a lighter foliage and is slightly more double.

FLAG OF TRUCE.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom single. Color (total effect) lilac white 3-4 (7); guards clear. Fragrance unpleasant XX. Blooming time early. Large size.

Description of plant — Habit of plant erect, medium to dwarf, compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit very free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins green.

Commercial value — Landscape value extra good single. Variety as a whole extra good.

Remarks — This is a better bloomer than "Countess of Warwick."

THE QUEEN.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom single. Color (total effect) lilac white 1 (7); guards slightly splashed. Very desirable, single white bloom. Fragrance unpleasant XX. Blooming time early. Large size.

Description of plant — Habit of plant erect, medium to tall, compact. Growth strong and healthy. Stem medium long, strong, green to reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium to light green, medium size; veins green.

Commercial value — For cut bloom poor; landscape value extra good. Variety as a whole good.

DOROTHY.

Pink

Species — P. albiflora. *Originated by* Kelway.

Donated by Thurlow.

Description of bloom — Type of bloom single. Form of bloom flat. Color (total effect) violet rose 4 (145); guards clear. Single row of guards, smooth carpels, red stigmas. Fragrance unpleasant XX. Blooming time mid-season. Size medium to large.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, medium strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage very well furnished, medium to light green, coarse; veins green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

EMILY.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom single. Form of bloom globular. Color (total effect) violet rose 1 (154). Double row of petals. Bloom does not open up wide. Fragrance unpleasant XX. Blooming time extra early. Medium size.

Description of plant — Habit of plant erect, medium to tall, medium compact. Growth strong and healthy. Stem medium to long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins red.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

Remarks — Not an especially clear, desirable color.

LEUCADIA.

Species — P. albiflora. *Originated by* Kelway.

Donated by Thurlow.

Description of bloom — Type of bloom single. Form of bloom flat. Color (total effect) solferino red 2 (157); guards clear; carpels green; smooth, white stigmas; collar petals silver tipped. Fragrance unpleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, coarse; veins green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

MAY DAVIDSON.

Species — P. albiflora. *Origin* unknown.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom single. Form of bloom flat, two rows of guards. Color (total effect) pale lilac rose 1 (178); guards clear; center a mass of yellow stamens; silver tipped bloom. One of the largest singles in existence. Fragrance pleasant XX. Blooming time mid-season. Very large size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, very strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole good.

VESTA.

Species — P. albiflora. *Originated by* Kelway.
Donated by Farr.
Description of bloom — Type of bloom single. Color (total effect) violet rose 1 (154); guards clear. Fragrance unpleasant XX. Blooming time early. Large size.
Description of plant — Habit of plant erect, medium tall, medium compact. Growth medium strong, healthy. Stem medium long, strong, red to reddish green. Blooming habit free. Buds single. Foliage medium furnished, medium green, medium size; veins reddish green.
Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.
Remarks — Similar to "Emily," possibly not as strong grower and slightly later season.

AUSTIN CHAMBERLAIN.

Red
Species — P. albiflora. *Originated by* Kelway, 1900-1907.
Donated by Farr.
Description of bloom — Type of bloom single. Color (total effect) amaranth red 4 (168); collar specked light. Fragrance unpleasant XXX. Blooming time early. Large size.
Description of plant — Habit of plant erect, tall to medium, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters. Foliage very well furnished, medium green, medium size; veins reddish green.
Commercial value — For cut bloom poor; landscape value good. Variety as a whole good.
Remarks — Similar to "The King" but better furnished, more compact grower, more petals, freer bloomer.

AUTUMNUS.

Species — P. albiflora. *Originated by* Kelway.
Donated by Farr.
Description of bloom — Type of bloom single. Form of bloom flat. Color (total effect) amaranth red 4 (168); guards clear. Fragrance unpleasant X. Blooming time extra early. Size medium.
Description of plant — Habit of plant erect, medium to dwarf, medium compact. Growth strong and healthy. Stem medium length, medium strength, red. Blooming habit medium. Buds of laterals developed (seldom). Foliage well furnished, medium green, medium size; veins red.
Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium to poor.
Remarks — Same color as "Austin Chamberlain" but not as free bloomer and more dwarf.

FLAG OF WAR.

Species — P. albiflora. *Originated by* Kelway.
Donated by Farr.
Description of bloom — Type of bloom single. Color (total effect) purple garnet 4 (165); guards clear. Fragrance unpleasant XX. Blooming time early. Large size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, vivid red. Blooming habit medium. Buds single. Foliage medium furnished, dark green, medium size; veins red.

Commercial value—For cut bloom poor; landscape value good. Variety as a whole good.

Remarks — Similar to "Frank Bramley" but darker foliage, darker red stems, and slightly brighter bloom, not quite as large, blooms single.

FRANK BRAMLEY.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom single. Color (total effect) rosy magenta 4 (169); guards clear; bloom has slight silver reflex. Fragrance unpleasant XX. Blooming time early. Size very large.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters. Foliage well furnished, dark green to medium green, medium size; veins red.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole good.

JUPITER.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom single. Color (total effect) rosy magenta 3 (169); guards clear. One of the most attractive single blooms of this color. Fragrance unpleasant XX. Blooming time early. Size medium to large.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, red. Blooming habit very free. Buds borne in clusters, healthy. Foliage well furnished, light green, medium size to fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value extra good. Variety as a whole extra good.

Remarks — Light green foliage distinguishes it from all other red singles. One of the best. Distinct from "Jupiter" (Calot, 1867).

MILLAIS.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom single. Color (total effect) dark crimson 4 (168); guards clear. Fragrance unpleasant XX. Blooming time early. Very large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters. Foliage medium furnished, medium green to dark green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole medium.

Remarks — Similar to "Flag of War," but not as dark stems or foliage, larger bloom.

STANLEY.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Descripion of bloom — Type of bloom single. Color (total effect) dark crimson 5 (165); guards clear. Fragrance unpleasant X. Blooming time early to mid-season. Large size.

Description of plant — Habit of plant erect, medium tall, medium compact. Growth strong and healthy. Stem medium long, strong, vivid red. Blooming habit free. Buds borne in clusters. Foliage medium furnished, dark green, medium size; veins red.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole good.

Remarks — Not as tall a grower as "Frank Bramley," possibly a heavier bloomer. "Stanley" is the better of the two varieties.

This variety should not be confused with "Stanley" (Crousse, 1879), which is a double sort. See Bulletin 278, page 292.

THE KING.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom single. Color (total effect) 4-5 (160) aniline red. Fragrance unpleasant XX. Blooming time early. Medium size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long to long, medium to strong, red. Blooming habit medium. Buds borne in clusters, slight blight. Foliage medium furnished, dark green to medium, medium size; veins red.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

JAPANESE TYPE

MODESTY.

White

Species — P. albiflora. *Originated by* Kelway.

Donated by Hollis.

Description of bloom — Type of bloom Japanese. Form of bloom flat, loose. Not entirely transformed. Differentiated. Color (total effect) white; guards clear, milk white; center clear, cream white. Hairy, green carpels, white stigmas. Fragrance pleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect, medium height, medium compact. Growth medium strong, healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, dark green, fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

WHITE LADY.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom Japanese. Differentiated. Not entirely transformed. Color (total effect) lilac white; guards clear; center clear, amber yellow. Double row of guards. Fragrance unpleasant X. Blooming time early to mid-season. Medium size.

Description of plant — Habit of plant erect, medium to dwarf, compact. Growth strong and healthy. Stem medium long to short, strong, green. Blooming habit free. Buds borne in clusters. Foliage well furnished, light green, medium size; veins green.

Commercial value — For cut bloom medium; landscape value extra good. Variety as a whole extra good.

Remarks — One of the most attractive Japanese blooms in the trade.

CINDERELLA.

Pink and White

Species — P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Description of bloom — Type of bloom Japanese. Form of bloom globular, medium compact. Differentiated. Not entirely transformed. Color (total effect) mauve and cream; guards 4 (181) pure mauve, streaked light; center cream white. Fragrance unpleasant X. Blooming time mid-season. Size medium.

Description of plant — Habit of plant very erect, medium to tall, compact. Growth strong and healthy. Stem long, strong, red. Blooming habit free. Lateral buds undeveloped. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium to good.

HITY TITY.

Pink

Species — P. albiflora. *Originated by* Hollis, 1909.

Donated by Hollis.

Description of bloom — Type of bloom Japanese. Form of bloom globular, very loose. Differentiated. Not entirely transformed. Color (total effect) pale lilac rose 2 (178); guards clear; center cream, clear. Green carpels, white stigmas. Fragrance unpleasant X. Blooming time mid-season. Small size.

Description of plant — Habit of plant erect, dwarf, compact. Growth medium strong, diseased. Stem short, medium strong, reddish green. Blooming habit shy. Lateral buds undeveloped, blight. Foliage well furnished, medium green, fine; veins green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole worthless.

INNOCENCE.

Species — P. albiflora. *Originated by* Hollis, 1904.

Donated by Hollis.

Description of bloom — Type of bloom Japanese. Form of bloom flat, medium compact to loose. Differentiated. Not entirely transformed. Color (total effect) 1 (152) lilac rose; guards clear; center canary yellow fading to cream white. Hairy, pale, yellowish green carpels and yellow stigmas. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

SUNBEAM.

Species — P. albiflora. *Originated by* Hollis, 1904.
Donated by Farr.

Description of bloom — Type of bloom Japanese. Form of bloom flat, loose. Differentiated. Not entirely transformed. Color (total effect) 1 (129) pale rose pink; guards clear; guards fade to lilac white; center canary yellow 1 (17) fading to cream white. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole medium.

SUNRISE.

Species — P. albiflora. *Originated by* Hollis, 1908.
Donated by Hollis.

Description of bloom — Type of bloom Japanese. Form of bloom globular, medium compact to compact. Differentiated. Entirely transformed. Color (total effect) pale lilac rose 1 (178); guards clear; center clear, canary yellow. Strong blooms produce crown of 1 or 2 petals flecked crimson. Fragrance pleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect to drooping, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, very coarse; veins red.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

ATTRACTION.

Red

Species — P. albiflora. *Originated by* Hollis, 1906.
Donated by Farr.

Description of bloom — Type of bloom Japanese. Form of bloom flat, medium compact. Differentiated. Not entirely transformed. Color (total effect) tyrian rose 4 (155); guards, tyrian rose, clear; center clear. Center same color as guards, tipped with yellow, fades more quickly than guards. Fragrance pleasant X. Blooming time mid-season. Very large size.

Description of plant — Habit of plant erect, medium to tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium to light green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

CROWN OF THORNS.

Species — P. albiflora. *Originated by* Hollis, 1907.
Donated by Hollis.

Description of bloom — Type of bloom Japanese. Form of bloom medium globular, compact. Differentiated. Not entirely transformed. Color (total effect) 1 (169) rosy magenta; guards clear; collar same as guards; center clear.

Smooth, green carpels, yellow stigma. Center fades much lighter than the guards. Fragrance pleasant XX. Blooming time early. Size medium to small.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong, slightly diseased. Stem medium long, medium strong, reddish green. Blooming habit medium. Buds borne in clusters. Slight blight. Foliage well furnished, medium green, fine; veins red.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

FLASHLIGHT.

Species — P. albiflora. *Originated by* Hollis, 1906.

Donated by Farr.

Description of bloom — Type of bloom Japanese. Form of bloom globular, medium compact to loose. Differentiated. Not entirely transformed. Color (total effect) tyrian rose 1 (155); guards have slight streak; center clear. The center is amber yellow, shading pink at base. Fragrance unpleasant X. Blooming time early. Very large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, red. Blooming habit free. Buds borne in clusters. Foliage well furnished, dark green, medium size; veins red.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

GLORY.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Farr.

Description of bloom — Type of bloom Japanese. Form of bloom flat, medium compact to loose. Color (total effect) 1 (155) tyrian rose; guards clear; center golden yellow. Bloom on strong plants, petals same color as guards will likely develop in center of bloom; silver tip. Fragrance unpleasant X. Blooming time mid-season to late. Size medium.

Description of plant — Habit of plant erect, medium tall, medium compact. Growth strong. Stem medium long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green to medium, fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

GYPSY.

Species — P. albiflora. *Originated by* Hollis, 1904.

Donated by Farr.

Description of bloom — Type of bloom Japanese. Form of bloom flat, loose. Differentiated. Entirely transformed. Color (total effect) 5 (155) tyrian rose; guards clear; center of bloom same color as guards. Does not fade as quickly as "Attraction." Fragrance unpleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, medium tall, medium compact. Growth strong and healthy. Stem long to medium, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, fine; veins green to reddish green.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole good.

PRINCE ALERT.

Species — P. albiflora. *Originated by* Hollis, 1904.
Donated by Hollis.
Description of bloom — Type of bloom Japanese. Form of bloom flat, medium compact. Differentiated. Not entirely transformed. Color (total effect) 1 (155) tyrian rose; guards clear; center clear; center pale pink with yellow remnants. Carpels pale green, pinkish white stigmas. Fragrance pleasant X. Blooming time late. Small to very small size.
Description of plant — Habit of plant erect, dwarf, compact. Growth medium strong, diseased. Stem short, strong, reddish green. Blooming habit shy. Buds borne in clusters, blight. Foliage well furnished, dark green, medium size; veins green.
Commercial value — For cut bloom poor; landscape value poor. Variety as a whole worthless.

WITCH.

Species — P. albiflora. *Originated by* Hollis, 1908.
Donated by Hollis.
Description of bloom — Type of bloom Japanese. Form of bloom globular, loose. Differentiated. Not entirely transformed. Color (total effect) 1 (155) tyrian rose; guards have light streaks; center same color as guards. Hairy, green carpels, white stigmas. Fragrance pleasant X. Blooming time midseason. Small size.
Description of plant — Habit of plant erect, medium tall, medium compact to compact. Growth strong and healthy. Stem medium long, medium strong to weak, red. Blooming habit medium. Lateral buds undeveloped, blight. Foliage well furnished, dark green, fine; veins red.
Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.
Remarks — Not an attractive bloom.

ANEMONE TYPE

GOLDEN WEDDING.

White
Species — P. albiflora. *Originated by* Pleas.
Donated by Cottage Gardens Company.
Description of bloom — Type of bloom anemone. Form of bloom globular, loose. Differentiated. Not entirely transformed. Color (total effect) yellowish white; guards splashed with rosy white; center canary yellow, clear. Carpels green, yellow stigmas. Bloom fades to creamy white center. Fragrance pleasant X. Blooming time early. Size large.
Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters. Foliage medium furnished, medium green, medium size; veins red.
Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

MORNING STAR.

Species — P. albiflora. *Originated by* Terry.

Donated by Farr.

Description of bloom — Type of bloom anemone. Form of bloom flat, loose. Differentiated. Not entirely transformed. Color (total effect) milk white; guards flecked with crimson. Very strong blooms produce petals in center with crimson flecks; 4-8 carpels, red stigmas. Fragrance pleasant X. Blooming time mid-season. Medium to small size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit free. Buds single, healthy. Foliage well furnished, light green, medium size; veins green.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole good.

YOUTH.

Species — P. albiflora. *Originated by* Hollis, 1908.

Donated by Hollis.

Description of bloom — Type of bloom anemone. Form of bloom flat, loose. Differentiated. Not entirely transformed. Color (total effect) milk white; guards clear; center cream white, clear. Hairy, green carpels, white stigmas; very strong blooms occasionally show crown. Fragrance pleasant X. Blooming time mid-season. Medium to large size.

Description of plant — Habit of plant medium erect, tall, compact. Growth strong and healthy. Stem long, strong, green to reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

Pink and White

AURORA.

Species — P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Description of bloom —Type of bloom anemone. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect) solferino red 2 (157); guards clear; center cream to milk white, clear; secondary staminodes absent; linear petals. Strong blooms have few central petals same color as guards, flecked. Fragrance lacking. Blooming time mid-season. Size medium to large.

Description of plant — Habit of plant erect, medium to tall, very compact. Growth strong and healthy. Stem medium length, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size, veins green.

Commercial value — For cut bloom poor; landscape value, medium to good. Variety as a whole medium.

Remarks —"Arcadia" cannot be distinguished except that it may be a slightly lower growing plant. This should not be confused with "Aurora" originated by Mrs. Pleas, see Bulletin 278, page 237, nor with "Aurore" (Dessert).

Pink

GOLD NUGGET.

Species — P. albiflora. *Originated by* Pleas.
Donated by Pleas.

Description of bloom — Type of bloom anemone. Form of bloom globular, very loose. Differentiated. Not entirely transformed. Color (total effect) pale lilac rose; guards clear; collar cream white, lighter than guards; center clear; secondary staminodes absent. Green, hairy carpels, cream stigmas, crown formed by few large petals on strong blooms. Central petals ¼ inch wide. Fragrance unpleasant X. Blooming time early to mid-season. Large size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium to poor.

AUGUSTE LEMONIER.

Red

Species — P. albiflora. *Originated by* Calot, 1865.
Donated by Kline.

Description of bloom — Type of bloom anemone. Form of bloom flat, medium compact. Differentiated. Not entirely transformed. Color (total effect) reddish violet; guards, 3-4 (180), clear; center uniform color. Fragrance pleasant X. Blooming time mid-season. Medium to small in size.

Description of plant — Habit of plant erect, medium height, medium compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

CURIOSITY.

Species — P. albiflora. *Originated by* Dessert & Mechin, 1886.
Donated by Cottage Gardens Company.

Description of bloom — Type of bloom anemone. Weak blooms are nearly single, while very strong ones may be semi-double. Form of bloom medium globular, compact. Differentiated. Not entirely transformed. Color (total effect) 4 (180) reddish violet; guards clear; collar same as guards; center clear, tipped yellow. Green carpels, pink stigmas, occasional wide petal appearing in center. Fragrance pleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, fine; veins reddish green.

Commercial value — For cut bloom medium; for landscape value medium. Variety as a whole medium.

EUREKA.

Species — P. albiflora. *Originated by* Terry.
Donated by Farr.

Description of bloom — Type of bloom anemone. Form of bloom globular, compact. Differentiated. Not entirely transformed. Color (total effect) 4 (155) tyrian rose; guards streaked light in center; collar same as guards; center clear. The very strong blooms have a tendency to produce low crown. Fragrance unpleasant X. Blooming time mid-season. Small size.

Description of plant — Habit of plant medium erect, medium height, medium compact. Growth strong and healthy. Stem medium long, medium strong, red. Blooming habit medium to shy. Lateral buds undeveloped, healthy. Foliage well furnished, dark green, fine; veins red.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

L'AVENIR.

Species — P. albiflora. *Originated by* Calot, 1868.

Donated by Farr.

Description of bloom — Type of bloom anemone. Form of bloom globular, medium compact. Color (total effect) 1 (180) reddish violet; guards clear; center yellow and reddish violet. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, very strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium to fine in size; veins red.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

ROSEA MAGNA.

Species — P. albiflora. *Originated by* Guerin, 1856.

Donated by Blue Hill Nursery.

Description of bloom — Type of bloom anemone. Form of bloom globular, loose. Differentiated. Not entirely transformed. Color (total effect) 1 (169) rosy magenta; guards clear; center milk white, clear. Red carpels and red stigmas. Strong blooms have center mixed with petals of the same color as guards. Usually the central petals are ¼ inch wide. Fragrance pleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, coarse; veins green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

SEMI-DOUBLE TYPE

MADAME COURANT.

Pink and White

Species — P. albiflora. *Originated by* Courant, 1850.

Donated by De Graff Brothers.

Description of bloom — Type of bloom semi-double. Form of bloom flat, medium compact. Not differentiated. Color (total effect) pink and white; guards clear 2 (154) violet rose; center clear, fades lilac white; secondary staminodes absent. Smooth, green carpels and cream stigmas. Fragrance unpleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect to drooping, tall, compact.

Growth strong and healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, coarse; veins red.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

Synonyms — "Phoenica Variegata," "Perfection."

Pink

DAYBREAK.

Species — P. albiflora. *Originated by* Hollis, 1909.

Donated by Farr and Hollis.

Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) violet rose 4 (154); guards clear; uniform color throughout; center clear 4 (154). Fragrance unpleasant XX. Blooming time early. Size large.

Description of plant — Habit of plant medium erect, medium height, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit medium. Buds borne in clusters. Foliage medium furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole good.

EVENING GLOW.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom semi-double. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) hydrangea pink 1 (132) tipped with white, uniform color. Stamens are plainly visible in the center of the bloom when fully open. Imbricated bloom. Fragrance pleasant XX. Blooming time early. Size very large.

Description of plant — Habit of plant medium erect to erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, coarse; veins reddish green.

Commercial value — For cut bloom medium; landscape value good to extra good. Variety as a whole good.

Remarks — The center of the bloom fades pure white.

GENERAL CUSTER.

Species — P. albiflora. *Originated by* Terry.

Donated by Thurlow.

Description of bloom — Type of bloom semi-double. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect) light violet rose 1 (154); guards streaked; center clear; uniform color throughout. Fades to white in center and tips of petals. Fragrance unpleasant XX. Blooming time mid-season. Size large.

Description of plant — Habit of plant medium erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, medium green, coarse; veins green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

HARRIET BEECHER STOWE.

Species — P. albiflora. *Originated by* Hollis, 1907.
Donated by Hollis.
Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) hydrangea pink; fades to milk white in center; guards flecked and streaked crimson; center clear, lighter; secondary staminodes absent. Fragrance unpleasant XXX. Blooming time mid-season to early. Large size.
Description of plant — Habit of plant erect, medium tall to tall, compact. Growth strong and healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, dark green, coarse; veins red.
Commercial value — For cut bloom poor; landscape value medium to poor. Variety as a whole medium to poor.

MADAME CARPENTIER.

Species — P. albiflora. *Originated by* Delache, 1850.
Donated by Dessert.
Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) violet rose 3 (154); guards flecked; collar lighter than guards; center flecked with crimson; secondary staminodes absent. The center of bloom fades to lilac white. Fragrance pleasant X. Blooming time mid-season. Large size.
Description of plant — Habit of plant medium erect, medium height, medium compact. Growth medium strong, healthy. Stem medium long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, fine; veins red.
Commercial value — For cut bloom medium; landscape value good. Variety as a whole medium to good.

MADAME JOANNA SALLIER.

Species — P. albiflora. *Originated by* Paillet.
Donated by Shaylor and McKissock.
Description of bloom — Type of bloom semi-double. Form of bloom globular, medium compact. Not differentiated. Not entirely transformed. Color (total effect) 4 (154) violet rose; guards flecked with crimson, splashed with crimson; collar same color as guards; center prominently flecked with crimson. Fragrance unpleasant X. Blooming time early to mid-season. Large size.
Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium to dark green, medium size; veins red.
Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

NE PLUS ULTRA.

Species — P. albiflora. *Originated by* Miellez, 1856.
Donated by Farr.
Description of bloom — Type of bloom semi-double. Form of bloom flat, loose.

Not differentiated. Not entirely transformed. Color (total effect) pure mauve; uniform color throughout 1 (181); bloom silver tipped, slight splash. Fragrance pleasant X. Blooming time early to mid-season. Medium size.

Description of plant — Habit of plant medium erect, medium tall, medium compact to open. Growth strong. Stem medium long, medium strong, red. Blooming habit free. Buds single, healthy. Foliage medium furnished, light green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

SOUTH WEYMOUTH.

Species — P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) violet rose 3 (154); guards prominently splashed; collar same color as guards; center fades to lilac white, clear. Fragrance pleasant X. Blooming time early to mid-season, medium size.

Description of plant — Habit of plant erect, medium tall, medium compact. Growth medium strong, healthy. Stem medium long, medium strong, vivid red. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, dark green, medium size; veins red.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor to worthless.

THEODORE ROOSEVELT.

Species — P. albiflora. *Originated by* Pleas.

Donated by Wild.

Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) pale lilac rose 1 (178); guards splashed; collar same as guards; center slightly flecked crimson; secondary staminodes absent. Color is splashed on similarly to "Asa Gray." Fragrance unpleasant X. Blooming time early to mid-season. Large size.

Description of plant — Habit of plant drooping, medium tall, medium compact. Growth strong and healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, coarse; veins reddish green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

Remarks — "Delachei" has been confused with and sold under the above name.

WELCOME GUEST.

Species — P. albiflora. *Originated by* Hollis, 1904.

Donated by Farr.

Description of bloom — Type of bloom semi-double. Form of bloom loose. Not differentiated. Not entirely transformed. Color (total effect) bright rose 1 (128); guards clear; collar same color as guards; center clear. Bloom fades in sun. Fragrance pleasant XX. Mid-season. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters. Foliage medium furnished, medium green, coarse to medium in size; veins red.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

ADOLPHE ROUSSEAU.

Red

Species — P. albiflora. *Originated by* Dessert and Mechin, 1890.

Donated by Farr.

Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) purple garnet 5 (165), guards streaked light, collar same as guards, center clear; secondary staminodes absent. Cream white carpels, pink stigma, stamens visible in center of bloom. Fragrance unpleasant X. Blooming time early. Size very large.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong, healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters. Foliage medium furnished, dark green, medium fine; veins red.

Commercial value — For cut bloom poor; landscape value extra good. Variety as a whole good.

Remarks — One of the best early reds for landscape.

ANTIETAM.

Species — P. albiflora. *Originated by* Hollis, 1905.

Donated by Hollis.

Description of bloom — Type of bloom semi-double. Form of bloom very flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect), guards dark crimson 4 (168); guards streaked with white; collar same color as guards; center same as guards, clear; secondary staminodes absent. Fragrance unpleasant X. Blooming time mid-season. Small size.

Description of plant — Habit of plant medium erect, medium to dwarf in height, compact. Growth medium strong, diseased. Stem medium to short in length, medium strong, red. Blooming habit shy. Buds have laterals undeveloped, blight. Foliage well furnished, dark green, fine; veins red.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole worthless.

CHARLES DE BELLEYME.

Species — P. albiflora. *Originated by* Verdier, 1860.

Donated by Farr.

Description of bloom — Type of bloom semi-double. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect) dark crimson 4 (168); collar same as guards; center clear. Some guard petals streaked lighter on lower side. Fragrance unpleasant X. Blooming time mid-season. Size medium.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins red.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole medium.

Remarks — There may be a slight doubt as to the identity of this variety.

CONTINENTAL.

Species—P. albiflora. *Originated by* Hollis, 1905.

Donated by Hollis.

Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) magenta 4 (182); guards flecked scarlet; uniform color, clear. Fades silver tipped, broad petals, imbricated bloom, yellow stamens visible at center. Fragrance unpleasant X. Blooming time mid-season. Size large.

Description of plant — Habit of plant erect, medium tall, very compact. Growth strong and healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, coarse; veins red.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole medium.

DESCARTES.

Species — P. albiflora. *Originated by* Dessert & Mechin, 1885.

Donated by Shaylor.

Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) aniline red 4 (160); guards clear; collar same as guards; center streaked light. Fragrance pleasant X. Blooming time mid-season. Size large.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value very good. Variety as a whole medium to good.

EUGÈNE REIGNOUX.

Species — P. albiflora. *Originated by* Dessert.

Donated by Farr.

Description of bloom — Type of bloom semi-double. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect) magenta 4 (182); guards have occasional light streak; collar same as guards; center clear. Fragrance unpleasant X. Blooming time early to mid-season. Size large.

Description of plant — Habit of plant erect, medium height, medium compact. Growth strong. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium to dark green, medium size; veins red.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

JOHN HANCOCK.

Species — P. albiflora *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom semi-double. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect) 4 (169) rosy magenta; guards streaked light; center clear; secondary staminodes absent. Bloom is very noticeably silver tipped. Fragrance unpleasant XX. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem long, medium strong to strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

LA SUBLIME.

Species — P. albiflora. *Originated by* Parmentier, 1850.

Donated by Perennial Gardens.

Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) 5 (168) dark crimson; guards streaked light; collar same color as guards; center clear. Carpels pale yellow, pink stigmas, smooth. Fragrance unpleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, dark green, fine; veins green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

MILES STANDISH.

Species — P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Description of bloom — Type of bloom semi-double. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect) dark crimson 5 (168); guards streaked light; center same as guards, clear. Green carpels, smooth, pink stigmas. Fragrance unpleasant X. Blooming time mid-season. Medium to small size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, medium strong, reddish green. Blooming habit medium to free. Lateral buds undeveloped, healthy. Foliage medium furnished, dark green, medium to fine in size; veins red.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole worthless.

Remarks — Very unattractive, loose bloom.

NICO.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom semi-double. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect)

4 (155) tyrian rose; guards clear; collar same as guards; center clear; bloom silver tipped. Fragrance unpleasant X. Blooming time mid-season. Very large size.

Description of plant — Habit of plant medium erect, tall, open. Growth strong and healthy. Stem long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

Remarks — This variety was originally catalogued by Kelway as a single variety, but seems to be gradually doubling under cultivation.

RUBRA TRIUMPHANS.

Species — P. albiflora. *Originated by* Delache, 1854.

Donated by Farr.

Description of bloom — Type of bloom semi-double. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect) 5 (168) dark crimson; guards clear; collar same as guards; center clear. Fragrance unpleasant XX. Blooming time early. Large size.

Description of plant — Habit of plant medium erect, medium tall to tall, medium compact. Growth strong and healthy. Stem long, medium strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, dark green, medium size; veins vivid red.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

SOUVENIR DU DOCTEUR BRETONNEAU.

Species — P. albiflora. *Originated by* Dessert, 1896.

Donated by Shaylor.

Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) 5 (155) tyrian rose; guards clear; collar same as guards; center clear. Fragrance unpleasant XX. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

CROWN TYPE

ADELAIDE E. HOLLIS.

White

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Farr and Hollis.

Description of bloom. — Type of bloom crown. Form of bloom globular, medium compact. Differentiated. Entirely transformed. Color (total effect) rose white 1 (8), guards clear, collar same as guards, center clear. Very clear even pleasant color, fades to pure white. Fragrance pleasant XX. Blooming time mid-season. Size large.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong, healthy. Stem medium long to medium strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, medium fine; veins green.

Commercial value — For cut bloom extra good; landscape value good. Value of variety as a whole extra good.

ANTOINE POITEAU.

Species — P. albiflora. *Originated by* Guerin, 1845.

Donated by Charlton.

Description of bloom — Type of bloom crown. Form of bloom globular, medium compact. Differentiated. Entirely transformed. Color (total effect) lilac white; guards clear; collar milk white, lighter than guards; center flecked with crimson, same color as guards; secondary staminodes present. Opens like bomb but develops to low crown. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant medium to drooping, tall, medium compact. Growth strong, healthy. Stem long, strong, green. Blooming habit free. Buds undeveloped, healthy. Foliage medium furnished, medium green, fine; veins green.

Commercial value — For cut bloom good; landscape value medium. Variety as a whole medium to good.

BLANCHE CIRE.

Species — P. albiflora. *Origin* unknown.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom crown. Form of bloom medium compact. Differentiated. Entirely transformed. Color (total effect) cream white; guards clear; collar same as guards; center clear; secondary staminodes present. Fragrance pleasant X. Blooming time early. Medium size.

Description of plant — Habit of plant erect, medium tall, medium compact. Growth medium, healthy. Stem medium long, medium strength, reddish green. Blooming habit medium. Buds borne in clusters, slight blight. Foliage medium furnished, medium green, medium size; veins green.

Commercial value — For cut bloom good; landscape value medium. Variety as a whole good.

GRAZIELLA.

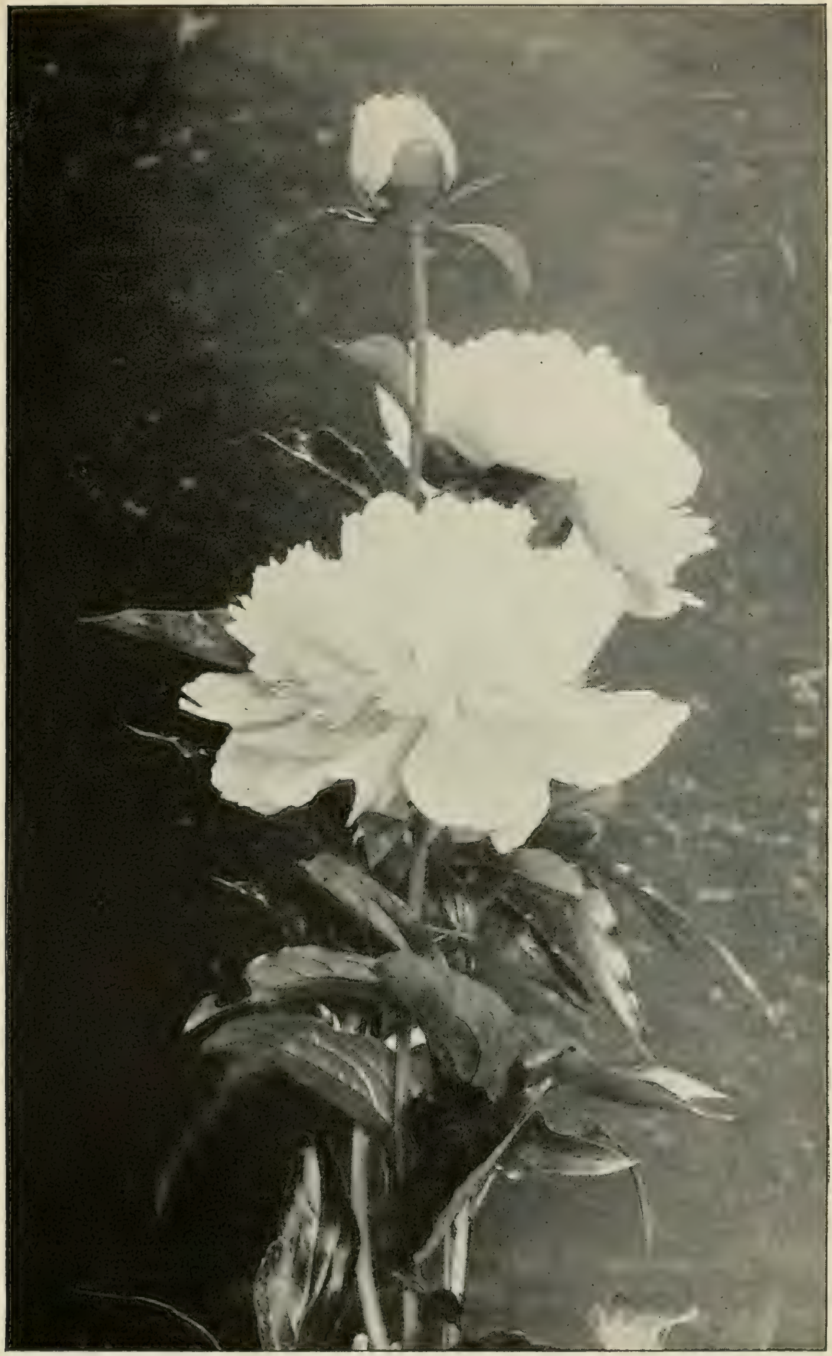
Species — P. albiflora. *Origin* unknown.

Donated by Shaylor from Dessert.

Description of bloom — Type of bloom crown. Form of bloom medium globular, loose. Differentiated. Not entirely transformed. Color (total effect) 1 (7) lilac white; guards clear; collar canary yellow when bloom first opens; center clear. Red stigma, smooth, green carpels. Fragrance unpleasant XX. Blooming time mid-season. Size medium to large.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.



Octave Demay (crown type)

LA VESTALE.

Species — P. albiflora. *Originated by* Calot, 1870.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom crown. Form of bloom tall, medium compact. Differentiated. Entirely transformed. Color (total effect) lilac white; guards slightly splashed; collar cream white; center lilac white flecked with crimson. Fragrance unpleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size to coarse; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

MADAME GUYOT.

Species — P. albiflora. *Originated by* Paillet.

Donated by McKissock.

Description of bloom — Type of bloom crown. Form of bloom globular, compact. Differentiated. Not entirely transformed. Color (total effect) 1 (15) greenish white; guards clear, slightly tinted with light pink; collar darker than guards, 2 (18) sulphur yellow; center flecked with crimson. Fragrance pleasant XX. Blooming time mid-season. Medium to large size.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem medium long, medium strong to strong, reddish green. Blooming habit free. Buds single, laterals undeveloped, healthy. Foliage medium furnished, medium green, coarse; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

MADAME SAVREAU.

Species — P. albiflora. *Originated by* Paillet.

Donated by McKissock.

Description of bloom — Type of bloom crown. Form of bloom globular, compact. Differentiated. Not entirely transformed. Color (total effect) lilac white; guards clear; collar cream yellow 1 (30); center flecked with scarlet. Fragrance unpleasant X. Blooming time mid-season to early. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, medium strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins green.

Commercial value — For cut bloom extra good; landscape value good. Variety as a whole extra good.

MARCELLE DESSERT.

Species — P. albiflora. *Originated by* Dessert, 1899.

Donated by Farr.

Description of bloom — Type of bloom crown. Form of bloom tall, medium compact. Differentiated. Entirely transformed. Color (total effect) milk white; guards slightly flecked with scarlet, splashed with lilac; center slightly flecked with crimson. Bloom very highly built. Fragrance pleasant XXX. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect, medium height, medium compact. Growth strong, healthy. Stem medium long, medium strong, red. Blooming habit medium. Buds single. Foliage well furnished, dark green, medium; veins reddish green.

Commercial value — For cut bloom good; landscape value medium. Variety as a whole good.

MISS SALWAY.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom — Type of bloom crown. Form of bloom globular, compact. Differentiated. Entirely transformed. Color (total effect) lilac white 2 (7); guards clear; collar lighter than guards; center clear. Fragrance pleasant X. Blooming time mid-season. Very large size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom extra good; landscape value extra good. Variety as a whole extra good.

Remarks — Very similar to "Madame Lemoine"; taller crown, however, and not as compact.

NEPTUNE.

Species — P. albiflora. *Originated by* Dessert.

Donated by Farr.

Description of bloom — Type of bloom crown. Form of bloom medium compact. Differentiated. Not entirely transformed. Color (total effect) lilac white; guards clear; collar lighter than guards, milk white; center clear. Cream white stigmas. Fragrance pleasant X. Blooming time mid-season. Size large.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium to dark green, coarse; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

PRESIDENT WILDER.

Species — P. albiflora. *Originated by* Ellwanger & Barry.

Donated by Ellwanger & Barry.

Description of bloom — Type of bloom crown. Form of bloom globular, compact. Differentiated. Not entirely transformed. Color (total effect) lilac white 2 (7); guards clear; collar milk white, lighter than guards; center same color as guards, occasionally slightly flecked with crimson; secondary staminodes present. Very compact crown, narrow collar. Fragrance pleasant XX. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, medium tall, medium compact. Growth medium strong, healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins green.

Commercial value—For cut bloom good; landscape value good. Variety as a whole good.

QUEEN VICTORIA (Kelway).

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom—Type of bloom crown. Form of bloom medium globular, medium compact to loose. Differentiated. Entirely transformed. Color (total effect) white; guards milk white, slightly flecked with crimson, slightly splashed crimson; collar cream white; center prominently flecked with crimson; secondary staminodes present on some blooms. Strong blooms have a low crown; weak blooms more of a loose bomb. Fragrance pleasant X. Blooming time mid-season. Large to medium size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins green.

Commercial value—For cut bloom medium; landscape value medium. Variety as a whole medium.

Remarks—Should not be confused with the "Queen Victoria Whitleyi" group. This variety is prominently flecked. For a description of "Whitleyi" see page 106.

SEA FOAM.

Species — P. albiflora. *Originated by* Peterson.

Donated by Cottage Gardens Company.

Description of bloom—Type of bloom crown. Form of bloom globular, medium compact. Differentiated. Entirely transformed. Color (total effect) lilac white 1 (7), fades to nearly pure white; guards clear; collar cream white; center clear, same color as collar. Fragrance pleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

SULFUREA.

Species — P. albiflora. *Originated by* Lemon, 1830.

Donated by Andorra Nurseries.

Description of bloom—Type of bloom crown. Form of bloom globular. Differentiated. Not entirely transformed. Color (total effect) milk white, slight yellowish green tint; guards clear; center clear, slight yellowish green tint at base of petals. Has a distinct cup shape when bloom first opens. Carpels hairy, cream white with white stigmas. Fragrance pleasant X. Mid-season. Large size.

Description of plant—Habit of plant medium erect to drooping, medium tall, medium compact. Growth medium strong. Stem medium long, medium strong, green. Blooming habit shy. Buds blighted. Foliage well furnished, medium green, fine in size; veins green.

Commercial value — For cut bloom good; landscape value medium. Variety as a whole medium to good.

Remarks — This is entirely distinct from "Alba Sulfurea." See page 102. Should not be confused with "Solfatare," see page 250, Bulletin 278.

TRIUMPHATA.

Species — P. albiflora. *Origin* unknown.

Donated by Goos and Koenemann.

Description of bloom — Type of bloom crown. Form of bloom globular, medium compact. Differentiated. Entirely transformed. Color (total effect) milk white; guards slightly streaked with crimson; collar same color as guards; center flecked with crimson; secondary staminodes present. Fragrance pleasant X. Blooming time mid-season. Medium to large size.

Description of plant— Habit of plant medium erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins green.

Commercial value — For cut bloom medium; variety as a whole medium.

Pink and White

EASTERN BEAUTY.

Species — P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Description of bloom — Type of bloom crown. Form of bloom tall, medium compact. Color (total effect) pink and white; guards 4 (154) violet rose, clear; collar lighter than guards, cream white with remnants of anthers; center flecked with crimson, same color as guards; secondary staminodes present. Color fades rapidly in sunlight. Fragrance pleasant XX. Blooming time mid-season to late. Size large.

Description of plant — Habit of plant medium erect, medium tall, compact. Growth strong and healthy. Stem medium to long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, coarse; veins reddish green.

Commercial value — Description of bloom poor; landscape value poor. Variety as a whole poor.

LUTETIANA.

Species — P. albiflora. *Originated by* Guerin, 1840.

Donated by Dessert.

Description of bloom — Type of bloom crown. Form of bloom globular, medium compact. Differentiated. Not entirely transformed. Color (total effect) pink and white; guards 2 (152) lilac rose; collar lighter than guards; center clear. The weak blooms are more bomb type with clear white center. Hairy, pale carpels and pink stigmas. Fragrance pleasant XX. Blooming time mid-season to late. Size medium to large.

Description of plant—Habit of plant medium erect to drooping, medium height, medium compact. Growth strong and healthy. Stem medium long, medium strong, green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium green, fine; veins green.

Commercial value — For cut bloom medium; landscape value medium to poor. Variety as a whole medium.

MADAME LEMOINE.

Species — P. albiflora. *Originated by* Calot, 1864.

Donated by Farr.

Description of bloom — Type of bloom crown. Form of bloom globular, very compact. Differentiated. Entirely transformed. Color (total effect) violet rose and milk white; guards 1 (154), collar lighter than guards, milk white; center crown lilac white; secondary staminodes present. Fragrance pleasant XXX. Blooming time mid-season. Large size.

Description of plant—Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium to coarse in size; veins green.

Commercial value—For cut bloom extra good; landscape value extra good. Variety as a whole extra good.

MADEMOISELLE ROSE RENDATLER.

Species—P. albiflora. *Originated by* Calot, 1867.

Donated by Jackson and Perkins.

Description of bloom—Type of bloom crown. Form of bloom tall, loose. Differentiated. Not entirely transformed. Color (total effect) hydrangea pink and cream; guards hydrangea pink 4 (7); guards very clear; collar cream, lighter than guards; center flecked; secondary staminodes present. Fragrance pleasant XX. Blooming time mid-season. Large size.

Description of plant—Habit of plant medium erect, medium height, medium compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, dark green, fine; veins reddish green.

Commercial value—For cut bloom medium; landscape value medium. Variety as a whole medium.

MRS. JOHN SMYTHE FOGG.

Species—P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom—Type of bloom crown. Form of bloom tall, medium compact to compact. Differentiated. Not entirely transformed. Color (total effect) pink and white; guards pale lilac fading to hydrangea pink, streaked light; collar lighter than guards, milk white; center clear, same color as guards; secondary staminodes absent. Weak blooms are more of a loose, bomb type. Fragrance pleasant X. Blooming time mid-season. Large size.

Description of plant—Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, coarse; veins reddish green.

Commercial value—For cut bloom medium; landscape value good. Variety as a whole good.

PRINCESSE NICOLAS BIBESCO.

Species—P. albiflora. *Originated by* Guerin, 1863.

Donated by Dessert.

Description of bloom—Type of bloom low crown. Form of bloom globular compact. Differentiated. Entirely transformed. Color (total effect) hydrangea pink and cream; guards hydrangea pink 1 (132), clear; collar cream white, lighter than guards, center crown same as guards, clear; secondary staminodes present. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Pink

BEAUTY'S MASK.

Species — P. albiflora. *Originated by* Hollis, 1904

Donated by Farr.

Description of bloom—Type of bloom crown. Form of bloom compact. Color (total effect) violet-rose 4 (154); guards clear; collar lighter than guards, mixed with cream yellow; secondary staminodes present. Fragrance pleasant X. Blooming time late. Very large size.

Description of plant — Medium erect habit, tall, open. Growth strong and healthy. Stem long, medium strength, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size, veins green.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole medium to good.

CHRISTOPHER ARCHARD.

Species — P. albiflora. *Origin* unknown.

Donated by Rosenfield

Description of bloom—Type of bloom crown. Form of bloom globular, medium compact. Differentiated. Nearly transformed. Color (total effect) mauve rose 1 (153); guards clear; collar milk white, lighter than guards; center same color as guards, flecked with crimson. Some weak blooms are typical bomb. Fragrance pleasant XX. Blooming time mid-season. Size medium to large.

Description of plant—Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, fine; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

COMTE DE JUSSIEU.

Species — P. albiflora. *Originated by* Guerin, 1850.

Donated by Jackson and Perkins.

Description of bloom — Type of bloom crown. Form of bloom globular, loose. Differentiated. Entirely transformed. Color (total effect) hydrangea pink; guards streaked light; collar lighter than guards, milk white; center flecked with crimson and green; secondary staminodes present. Fragrance unpleasant X. Blooming time early. Size medium to large.

Description of plant—Habit of plant erect, medium tall, medium compact. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins reddish green.

Commercial value—For cut bloom medium; landscape value medium. Variety as a whole medium.

Remarks — Identity not fully established.

COUPE D'HEBE.

Species — P. albiflora. *Originated by* Kelway.

Donated by Minot.

Description of bloom—Type of bloom crown. Form of bloom globular, medium compact. Color (total effect) 1 (178) pale lilac rose; guards clear; collar milk white, very much lighter than guards, center same as guards, flecked crimson; secondary staminodes absent. Fragrance pleasant XX. Blooming time mid-season. Size large.

Description of plant — Habit of plant medium to erect, very tall, medium compact. Growth strong and healthy. Stem long, very strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, coarse; green veins.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

CYTHÉRÉE.

Species — P. albiflora. *Originated by* Calot, 1856.

Donated by Shaylor.

Description of bloom — Type of bloom crown. Form of bloom globular, compact. Differentiated. Entirely transformed. Color (total effect) 1 (153) mauve rose; guards clear; collar lighter than guards, cream white; center prominently flecked with crimson; secondary staminodes present. Blooming time mid-season. Size medium to large.

Description of plant — Habit of plant erect, medium to tall, compact. Growth strong and healthy. Stem long and strong. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium to light green, medium size; veins green.

Commercial value — For cut bloom good; landscape value extra good. Variety as a whole good.

Remarks—Under the above name, a white peony has often been sold by European dealers. This should not be confused with Cyntherii, see Bulletin 278, page 247.

GERMAINE BIGOT.

Species — P. albiflora. *Originated by* Dessert, 1902.

Donated by Farr.

Description of bloom — Type of bloom crown, partly concealed stamens. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) pale lilac rose 2 (130); guards splashed with crimson; collar same as guards; center prominently flecked with crimson. Fragrance unpleasant X. Blooming time mid-season. Very large size.

Descripion of plqnt — Habit of plant erect, medium height, medium compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value—For cut bloom good; landscape value extra good. Variety as a whole good.

LA FÉE.

Species — P. albiflora. *Originated by* Lemoine.
Donated by McKissock.

Description of bloom — Type of bloom crown. Form of bloom globular, compact. Differentiated. Not entirely transformed; color (total effect) mauve rose 2 (153); guards clear; collar lighter than guards, creamy white; center clear. Fragrance pleasant XXX. Blooming time early. Large size.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, medium strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, very dark green, coarse; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Remarks — Foliage is very distinct. Leaflets are curled up.

MADAME JULES ELIE.

Species—P. albiflora. *Originated by* Calot, 1873.
Donated by Cottage Gardens Company.

Description of bloom — Type of bloom crown. Form of bloom globular, medium compact to loose. Differentiated. Not entirely transformed. Color (total effect) violet rose 2 (154); guards clear; collar lighter than guards, cream white; center flecked with crimson. Fragrance pleasant XX. Blooming time mid-season. Medium size.

Description of plant — Habit of plant medium erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit medium to free. Buds borne in clusters, blight. Foliage well furnished, medium green, medium to fine in size; veins reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

Remarks — Some doubt as to the identity of this one.

MYRTLE.

Species — P. albiflora. *Originated by* Terry.
Donated by Wild.

Description of bloom — Type of bloom crown. Form of bloom globular, medium compact. Differentiated. Not entirely transformed. Color (total effect) hydrangea pink, fades to lilac white; guards clear; collar lighter than guards; center clear. Light green carpels, pink stigmas. When bloom first opens it is bomb; later develops low, compact crown. Fragrance pleasant XXX. Blooming time mid-season. Size medium to small.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds single, healthy. Foliage well furnished, medium to light green, medium size; veins green to reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium to good.

Remarks — Bloom is too small to make a valuable variety.

PRINCESS OF WALES.

Species — P. albiflora. *Originated by* Kelway.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom crown. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) mauve rose 1 (153); guards flecked with crimson; collar lighter than guards; center clear. Fragrance pleasant XX. Blooming time late. Large size.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth strong and healthy. Stem medium long, strong, red. Blooming habit free. Buds borne in clusters. Foliage medium furnished, light green, medium to fine in size; veins reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

SIMONNE CHEVALIER.

Species — P. albiflora. *Originated by* Dessert, 1902.

Donated by Farr.

Description of bloom—Type of bloom crown. Form of bloom medium compact to loose. Differentiated. Entirely transformed. Color (total effect) pale lilac rose 1 (178); guards clear; collar cream white, lighter than guards; center same color as guards; flecked with crimson; secondary staminodes absent. Not a typical crown; collar not prominent. Fragrance pleasant XX. Blooming time early. Large size.

Description of plant — Habit of plant medium to drooping, medium tall, medium compact. Growth medium strong. Stem medium long, medium strong, reddish green. Blooming habit medium. Buds borne in clusters. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom medium to poor; landscape value good. Variety as a whole medium to good.

TAGLIONI.

Species — P. albiflora. *Originated by* Guerin, 1830.

Donated by Shaylor.

Description of bloom—Type of bloom crown. Form of bloom medium tall, medium compact. Differentiated. Entirely transformed. Color (total effect) 1 (154) violet rose; guards clear; collar cream white, lighter than guards; center very prominently flecked with crimson; secondary staminodes present, cream white. Fragrance unpleasant X. Blooming time early. Medium size.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters. Foliage medium furnished, light green, medium size; veins green to reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

VAN DYCK.

Species — P. albiflora. *Originated by* Crousse, 1879.

Donated by Blue Hill Nursery.

Description of bloom—Type of bloom crown. Form of bloom globular, medium compact to loose. Differentiated. Not entirely transformed. Color (total effect) mauve rose 2 (153); guards pure mauve; collar cream white, lighter than guards; center same color as guards, clear. Pink carpels and pink stigmas. Fragrance pleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters. Foliage well furnished, medium green, fine; veins green.

Commercial value — For cut bloom medium; landscape value medium to good. Variety as a whole medium.

VENUS.

Species—P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom—Type of bloom crown. Form of bloom tall, medium compact. Differentiated. Color (total effect) hydrangea pink 1 (132); guards clear; collar lighter than guards; center clear. Fragrance pleasant XX. Blooming time mid-season. Large to very large in size.

Description of plant—Habit of plant medium erect, very tall, medium compact. Growth strong and healthy. Stem long, medium strong, green. Blooming habit free. Buds borne in clusters. Foliage medium furnished, medium green, medium size; veins green.

Commercial value — For cut bloom extra good; landscape value good. Variety as a whole extra good.

Synonyms —“ Pearl,” “ Princess May,” “Marie Stuart.” (Mr. Farr thinks the Cornell “ Marie Stuart ” is incorrect.)

VICOMTESSE DE BELLEVAL.

Species — P. albiflora. *Originated by* Guerin, 1852.

Donated by Ellwanger & Barry.

Description of bloom — Type of bloom crown. Form of bloom flat, loose. Not differentiated. Entirely transformed. Color (total effect) hydrangea pink 1 (132); guards clear; collar cream white, lighter than guards; center same color as guards faded; secondary staminodes present, cream white. Fragrance pleasant X. Blooming time early. Medium size.

Description of plant — Habit of plant medium erect, medium tall, compact. Growth strong. Cornell specimens diseased. Stem medium long, medium strong, reddish green. Blooming habit medium. Buds borne in clusters, slightly blighted. Foliage well furnished, medium green, fine; veins reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

CLEMENTINE GILLOT.

Red

Species—P. albiflora. *Originated by* Crousse, 1885.

Donated by Farr and Goos and Koenemann.

Description of bloom—Type of bloom crown. Form of bloom tall, medium compact. Differentiated. Not entirely transformed. Color (total effect) 1 (155) tyrian rose; guards clear; collar same as guards; center clear. Bloom fades violet rose in the sun. Fragrance lacking. Blooming time late. Large size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, green. Blooming habit medium. Lateral buds undeveloped. Foliage well furnished, medium green, coarse; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

ELIE CHEVALIER.

Species—P. albiflora. *Originated by* Dessert, 1908.

Donated by Farr.

Description of bloom — Type of bloom crown to bomb. Form of bloom globular, medium compact. Not differentiated. Entirely transformed. Color (total effect) 2-3 (155) tyrian rose; guards splashed with green; collar same as guards; center flecked scarlet; uniform color throughout. Fragrance pleasant X. Blooming time mid-season. Size large.

Description of plant — Habit of plant drooping, tall. Growth medium to open. Stem long, medium strong, red. Blooming habit free. Buds single. Foliage medium furnished, medium green, medium to fine size; veins reddish green.

Commercial value—For cut bloom good; landscape value medium. Variety as a whole good.

GETTYSBURG.

Species — P. albiflora. *Originated by* Hollis, 1909.

Donated by Hollis.

Description of bloom — Type of bloom crown. Form of bloom globular, compact. Differentiated. Entirely transformed. Color (total effect) tyrian rose 1 (155); guards clear; collar same as guards; center clear; uniform color throughout; secondary staminodes present. Fragrance pleasant X. Blooming time very late. Medium to small size.

Description of plant — Habit of plant erect, tall, medium compact. Growth medium strong, healthy. Stem long, medium strong, reddish green. Blooming habit medium. Lateral buds undeveloped. Foliage medium to poorly furnished, dark green, fine; veins green.

Commercial value—For cut bloom poor; landscape value medium. Variety as a whole medium to poor.

MADAME BIGOT.

Species — P. albiflora. *Originated by* Dessert, 1893.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom crown. Form of bloom globular, compact. Differentiated. Entirely transformed. Color (total effect) 1 (155) tyrian rose; guards clear; collar lighter than guards, slight silver tip; center clear; secondary staminodes present. Fragrance unpleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect, medium height, compact. Growth medium strong, healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters, tend to blight. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value—For cut bloom medium; landscape value medium. Variety as a whole medium.

PURPUREA SUPERBA.

Species—P. albiflora. *Originated by* Delache, 1855.
Donated by Ellwanger & Barry.
Description of bloom — Type of bloom crown. Form of bloom globular, compact. Differentiated. Color (total effect) 4 (169) rose magenta; guards streaked white; center clear; uniform color throughout. Light green carpels, pink stigma. Fragrance unpleasant X. Blooming time mid-season. Large size.
Description of plant — Habit of plant erect, very tall, medium compact. Growth strong and healthy. Stem very long, strong, reddish green. Blooming habit free. Buds borne in clusters. Foliage medium furnished, medium green, medium size; veins green.
Commercial value—For cut bloom medium; landscape value good. Variety as a whole good.

BOMB TYPE

ALBA SULFUREA.

Species — P. albiflora. *Originated by* Calot, 1860.
Donated by Cottage Gardens Company.
Description of bloom — Type of bloom bomb. Form of bloom globular, compact. Differentiated. Not entirely transformed. Color (total effect) cream white, guards clear, collar same as guards, center very slightly flecked. stigmas red but fully concealed, very close examination showing a very minute fleck. Fragrance pleasant X. Blooming time mid-season. Size very large to large.
Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong, healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium fine; veins green.
Commercial value—For cut bloom extra good; landscape value good. Variety as a whole good.
Remarks — Distinct and superior to "Sulfurea," also more compact. "Sulfurea" has cream white stigmas, while stigmas of "Alba Sulfurea" are red.

ALBERT CROUSSE.

Species — P. albiflora. *Originated by* Crousse, 1893.
Donated by Cottage Gardens Company.
Description of bloom — Type of bloom bomb. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) rose white 3 (8), guards clear, collar same as guards, center flecked slightly crimson. Fragrance pleasant. Blooming time late. Very large size.
Description of plant — Habit of plant erect, tall, medium compact. Growth strong, healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium fine; veins green.
Commercial value — For cut bloom extra good; landscape value good. Variety as a whole good.

ALICE DE JULVÉCOURT.

Species — P. albiflora. *Originated by* Pele, 1857.

Donated by Cottage Gardens Company and Andorra Nurseries.

Description of bloom—Type of bloom bomb. Bloom is rather variable, as a crown type flower often appears. Form of bloom globular, compact. Differentiated. Entirely transformed. Color (total effect) lilac white, clear, collar cream, lighter than guards, center lilac white, prominently flecked with crimson; secondary staminodes present. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant—Habit of plant erect, medium tall, very compact. Growth strong, healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Synonyms — "Triumphans Gandavensis."

CANARIENSIS.

Species—P. albiflora. *Origin* unknown.

Donated by Storrs and Harrison.

Description of bloom—Type of bloom bomb. Form of bloom globular, compact. Differentiated. Not entirely transformed. Color (total effect) cream white; guards clear, milk white; center cream white with few flecks of crimson. Most of average blooms are not flecked. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, strong, green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Remarks — Very similar to "Duc de Wellington"; however, the latter variety never has any crimson flecks. This variety is distinct from "Canari," see Bulletin 278, page 231.

DELECOURT VERHILLE.

Species — P. albiflora. *Originated by* Delecourt Verhille, 1860.

Donated by Cottage Gardens Company.

Description of bloom—Type of bloom bomb. Form of bloom globular, medium compact. Differentiated. Not entirely transformed. Color (total effect) lilac white; center milk white, flecked with crimson. Carpels red, pink stigmas. Fragrance unpleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

EDULIS ALBA.

Species—P. albiflora. *Origin* unknown, 1835.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom bomb. Form of bloom tall, loose, slight crown. Differentiated. Entirely transformed. Color (total effect) lilac white; guards clear; center cream white, fades to milk white, flecked with crimson. Some blooms have low crown, same color as guards. Fragrance pleasant XX. Blooming time very early. Size medium to large.

Description of plant — Habit of plant drooping, medium tall, medium compact. Growth strong and healthy. Stem long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, coarse; veins reddish green.

Commercial value — For cut bloom good; landscape value medium. Variety as a whole medium to good.

ELEGANS SUPERBISSIMA.

Species — P. albiflora. *Originated by* Buyck, 1842.

Donated by Shaylor.

Description of bloom — Type of bloom bomb. Form of bloom medium globular, medium compact. Color (total effect) lilac white 1 (7); center cream white, clear. Yellow carpels with green stigmas. Fragrance pleasant XXX. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, coarse; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

GRIZZEL MUIR.

Species — P. albiflora. *Originated by* Kelway.

Donated by Cottage Gardens.

Description of bloom — Type of bloom bomb. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) creamy white; guards clear; collar same as guards; center clear. Fragrance unpleasant X. Blooming time late. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, medium strong, green. Blooming habit free. Buds borne in clusters, tend to blight. Foliage medium furnished, medium green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

MADEMOISELLE VAILLANT.

Species — P. albiflora. *Origin* unknown.

Donated by Farr.

Description of bloom — Type of bloom bomb. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect) milk white; guards clear; center cream white; secondary staminodes absent. Smooth, pale green carpel, pink stigmas. Fragrance pleasant XX. Blooming time early. Size large to very large.

Description of plant — Description of plant erect, medium tall to tall, compact. Growth strong and healthy. Stem long, very strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium to fine in size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

NIVEA PLENISSIMA.

Species—P. albiflora. *Originated by* Makoy, 1840

Donated by Farr.

Description of bloom—Type of bloom bomb. Form of bloom globular, medium compact. Differentiated. Not entirely transformed. Color (total effect) milk white; guards slightly splashed crimson; center clear; secondary staminodes absent. Carpels red, short hairs, might transform to flecked petals on old plants. Fragrance pleasant X. Blooming time early. Large size.

Description of plant — Habit of plant erect, dwarf, compact. Growth strong. Stem short, strong, dark red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins red.

Commercial value — For cut bloom good; landscape value extra good. Variety as a whole good to extra good.

Remarks—Dark red stems and white bloom are distinguishing characters of variety.

Correction to Bulletin 259. The above is a much better description of this variety.

RARE BROCADE.

Species—P. albiflora. *Originated in* Japan.

Donated by Rosenfield.

Description of bloom — Type of bloom bomb. Form of bloom flat, loose. Differentiated. Not entirely transformed. Color (total effect) pure white; guards occasionally flecked with crimson; center cream white, clear; secondary staminodes absent. Green, smooth carpels, pink stigmas; some blooms have tendency toward crown type. Fragrance pleasant X. Blooming time mid-season. Size medium.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth strong and healthy. Stem medium long, medium strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, medium size; veins green.

Commercial value—For cut bloom medium; landscape value medium. Variety as a whole medium.

REINE VICTORIA.

Species — P. albiflora. *Originated by* Guerin, 1845.

Donated by Cottage Gardens Company and Blue Hill Nursery.

Description of bloom — Type of bloom bomb. Form of bloom globular, medium compact. Differentiated. Entirely transformed. Color (total effect) lilac white and cream. Guards clear, lilac white; center cream white fading to milk white, flecked with crimson. Bases of central petals have cream tints, tips fading milk white. Tips of central petals have pinkish tint. Fragrance nearly lacking. Blooming time mid-season. Medium size.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth strong and healthy. Stem medium long, medium strong, green. Blooming habit medium to free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size to fine; veins reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

Remarks—This variety should not be confused with "Whitleyi," "Queen Victoria" group, see below, or "Queen Victoria" (Kelway), see page 93.

SABINA.

Species—P. albiflora. *Origin* unknown.

Donated by Goos and Koenemann.

Description of bloom — Type of bloom bomb. Form of bloom globular, loose. Differentiated. Not entirely transformed. Color (total effect) milk white; guards clear; collar same as guards; center same, clear. Red, hairy carpels, pink stigmas. Fragrance pleasant XX. Blooming time mid-season. Medium size.

Description of plant—Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, coarse; veins green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

WHITLEYI.

Species — P. albiflora. *Originated by* Whitley, 1808.

Donated by Andorra Nursery and John Charlton.

Description of bloom — Type of bloom bomb. Form of bloom globular, loose. Differentiated. Not entirely transformed. Color (total effect) milk white; guards slightly flecked with crimson; collar same color as guards; center clear. Hairy carpels, pink stigmas; bloom opens up exposing carpels with age. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, fine in size; veins green.

Commercial value — For cut bloom medium; landscape value medium to poor. Variety as a whole medium.

Synonyms—"Queen Victoria," "Papilionacea," "Snow White," "Rosa Barry," "Stewart's America."

BUYCKII.

Pink and White

Species — P. albiflora. *Originated by* Guerin, 1840.

Donated by Dessert.

Description of bloom — Type of bloom bomb. Form of bloom flat, loose. Differentiated. Not entirely transformed. Color (total effect) pink and white; guards 1 (152) lilac rose, clear; center milk white, clear. Carpels greenish red, smooth; pink stigmas. Strong blooms, show center flecked with crimson. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium length, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

Remarks — "Dr. Bretonneau" (Verdier) has been sold for the above variety, but there should be no confusion.

ADMIRAL DEWEY.

Pink

Species—P. albiflora. *Originated by* Hollis, 1903.

Donated by Hollis.

Description of bloom — Type bomb. Form of bloom, globular compact. Differentiated. Entirely transformed. Color (total effect) solferino red (157-2), clear; guards solferino red (157-2), clear; center same as guards; fades silver tipped, linear petals concealed throughout bloom. Fragrance pleasant X. Blooming time mid-season. Size medium.

Description of plant — Habit erect, medium to tall, compact. Growth strong, healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, coarse; veins reddish green.

Commercial value—For cut blooms poor; landscape value medium. Variety as a whole poor.

Remarks—There are many better varieties of this type.

CERES.

Species — P. albiflora. *Originated by* Verdier, 1860.

Donated by Cottage Gardens Company.

Description of bloom—Type of bloom bomb. Form of bloom medium globular, loose. Differentiated. Not entirely transformed. Color (total effect) pale lilac rose 1 (178); center very minutely flecked with scarlet. Red stigmas. Fragrance pleasant X. Blooming time very early. Large size.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium to coarse; veins red.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole good.

COMTE DE NANTEUIL.

Species — P. albiflora. *Originated by* Calot, 1858.

Donated by Farr.

Description of bloom — Type of bloom bomb. Form of bloom globular, medium to loose. Differentiated. Not entirely transformed. Color (total effect) violet rose 2 (154); guards clear; collar lighter than guards; center clear, salmon pink. Occasional wide petal in center same as guard. Fragrance pleasant XXX. Blooming time mid-season. Large size.

Description of plant—Habit of plant erect, tall, medium compact. Growth strong, healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, fine; veins green.

Commercial value—For cut bloom medium; landscape value medium. Variety as a whole medium.

DEPARTING SUN.

Species—P. albiflora. *Originated in* Japan.

Donated by Rosenfield.

Description of bloom — Type of bloom bomb. Form of bloom flat, loose. Differentiated. Not entirely transformed. Color (total effect) pale lilac rose 1 (178); guards splashed; collar same as guards; center same as guards, flecked with crimson. Smooth, greenish carpels, pink stigmas, color laid on in splashes; loose, unattractive bloom. Fragrance unpleasant XXX. Blooming time mid-season. Size medium.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

FAVORITE.

Species — P. albiflora. *Originated by* Terry.

Donated by Farr.

Description of bloom — Type of bloom bomb. Form of bloom globular, loose. Not clearly differentiated. Not entirely transformed. Color (total effect) 1 (154) violet rose; guards clear; collar same as guards; center clear; uniform color. Greenish red carpels, pink stigmas. Bloom silver tipped. Fragrance pleasant X. Blooming time mid-season to late. Medium size.

Description of plant — Habit of plant medium erect to drooping, medium height, medium compact to open. Growth strong and healthy. Stem medium long to long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, coarse; veins green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

GENERAL BEDEAU.

Species — P. albiflora. *Originated by* Calot, 1860.

Donated by Farr.

Description of bloom — Type of bloom bomb. Form of bloom globular, medium compact. Color (total effect) 3 (157) solferino red; guards clear; collar same as guards; center clear. Fragrance pleasant XXX. Blooming time mid-season. Size medium.

Description of plant — Habit of plant erect, medium height, compact. Growth strong. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, medium size; veins green.

Commercial value—For cut bloom medium; landscape value good. Variety as a whole medium.

GLORY OF SOMERSET.

Species — P. albiflora. *Originated by* Kelway.

Donated by Cottage Gardens Company.

Description of bloom—Type of bloom bomb, informal. Form of bloom flat, loose. Color (total effect) 3 (154) violet rose; guards clear; collar cream white, lighter than guards; center clear cream white and mixed with petals same color as guards. Carpels green with red stigmas. Fragrance pleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium to dark green, medium size; veins green.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole good.

HERCULES.

Species — P. albiflora. *Origin* unknown.

Donated by Goos and Koenemann.

Description of bloom—Type of bloom bomb. Form of bloom globular, loose. Differentiated. Not entirely transformed. Color (total effect) pale lilac rose; guards clear; center clear, fades milk white. Greenish red carpels, pink stigmas. Strong blooms have few wide petals same color as guards in center of bloom. Fragrance pleasant XX. Blooming time mid-season to late. Medium size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins green.

Commercial value—For cut bloom poor; landscape value medium. Variety as a whole medium.

LA FONTAINE.

Species — P. albiflora. *Originated by* Lemoine, 1904.

Donated by Farr.

Description of bloom—Type of bloom bomb. Form of bloom globular, compact. Differentiated. Entirely transformed. Color (total effect) violet rose 2 (154); guards clear; collar lighter than guards; center flecked with crimson. Guard petals very wide; lighter, narrow petals intermixed around the collar; center petals same color as guards. Fragrance pleasant X. Blooming time mid-season to late. Large size.

Description of plant — Habit of plant medium erect, tall, compact. Growth strong. Stem medium long to long, strong, reddish green. Blooming habit medium. Lateral buds occasionally undeveloped. Foliage well furnished, medium green, coarse; veins red.

Commercial value—For cut bloom good; landscape value extra good. Variety as a whole extra good.

Remarks — A very delicately colored variety, uniform shade, distinct from "La Fontaine" (Dessert, 1893) catalogued by Dessert, which is a crimson variety.

MADAME COSTÉ.

Species — P. albiflora. *Originated by* Calot, 1873.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom crown to bomb. Form of bloom globular, medium compact. Differentiated. Entirely transformed. Color (total effect) 1 (132) hydrangea pink; guards clear; collar cream white, lighter than guards; center flecked with crimson. Some blooms are bomb, while others have low crown. Fragrance pleasant XX. Blooming time early. Medium size.

Description of plant — Habit of plant medium erect, medium height, medium compact. Growth strong and healthy. Stem medium long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, fine; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Synonym — "Queen Esther."

MARIE CROUSSE.

Species — P. albiflora. *Originated by* Crousse, 1892.

Donated by Farr.

Description of bloom — Type of bloom bomb. Form of bloom globular, medium to loose. Differentiated. Not entirely transformed. Color (total effect) 1 (130) pale lilac rose; guards clear; collar same as guards; center clear. Fragrance unpleasant XX. Blooming time mid-season. Large to medium size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, medium strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium to fine in size; veins green.

Commercial value — For cut bloom extra good; landscape value good. Variety as a whole good to extra good.

MEADOWVALE.

Species — P. albiflora. *Originated by* Hollis, 1903.

Donated by Hollis.

Description of bloom—Type of bloom bomb. Form of bloom globular, compact. Differentiated. Not entirely transformed. Color (total effect) 4 (157) solferino red; guards clear; center occasionally flecked, same as guards. Hairy, yellow carpels, pink stigmas. Strong blooms showing tendency toward crowns. Fragrance pleasant XX. Blooming time mid-season. Medium size.

Description of plant — Habit of plant medium erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, coarse; veins green.

Commercial value — For cut bloom medium; landscape value medium to good. Variety as a whole medium to good.

Remarks — This variety is no real advance over many others of this color.

MONSIEUR JULES ELIE.

Species—P. albiflora. *Originated by* Crousse, 1888.

Donated by Farr.

Description of bloom — Type of bloom bomb. Form of bloom medium compact. Differentiated. Entirely transformed. Color (total effect) pale lilac rose; guards clear; center clear 2 (178); secondary staminodes present; collar tinted lighter than guards. Very attractive pink, base of collar petals amber yellow. Fragrance pleasant XX. Blooming time early. Large size.

Description of plant — Habit of plant medium erect, medium height, medium compact. Growth medium strong. Stem medium long, green. Blooming habit free. Foliage medium furnished, medium green, medium size; veins green.

Commercial value — For cut bloom very good; landscape value very good. Variety as a whole very good.

POMPON CHAMOIS.

Species—P. albiflora. *Originated by* Verdier, 1860.
Donated by Shaylor.

Description of bloom — Type of bloom bomb. Form of bloom globular, compact. Differentiated. Not entirely transformed. Color (total effect) 2 (154) violet rose; guards clear; collar canary yellow, lighter than guards; strong blooms have center same color as guards, streaked yellow; weak blooms have whole center yellow. Green carpels, pink stigmas. Fragrance unpleasant X. Blooming time mid-season. Small size.

Description of plant — Habit of plant drooping, medium tall, medium compact. Growth strong and healthy. Stem medium long, medium strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, dark green, fine; veins red.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

ROSEA ELEGANS.

Species—P. albiflora. *Originated by* Guerin, 1858.
Donated by Charlton.

Description of bloom — Type of bloom bomb. Form of bloom globular, compact. Differentiated. Not entirely transformed. Color (total effect) pale lilac rose; guards clear; collar cream white, fading to milk white; center clear; secondary staminodes absent. Occasionally central petals appear same color as guards, flecked with crimson. Fragrance pleasant X. Blooming time early. Medium size.

Description of plant — Habit of plant medium erect to drooping, tall, open. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, fine; veins green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

ROSILITA.

Species—P. albiflora. *Originated by* Hollis, 1907.
Donated by Hollis.

Description of bloom — Type of bloom bomb. Form of bloom globular, loose. Differentiated. Not entirely transformed. Color (total effect) 2 (154) violet rose; guards clear; center clear, milk white; secondary staminodes present. Hairy, green carpels, white stigmas. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant medium erect, medium tall, compact. Growth strong and healthy. Stem medium length, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

RUBICUNDA.

Species — P. albiflora. *Origin* unknown.
Donated by Charlton.

Description of bloom — Type of bloom bomb. Form of bloom tall, compact. Differentiated. Color (total effect) 3 (181) pure mauve; guards streaked light;

collar same as guards; center clear; uniform color throughout. Yellow carpels, pink stigmas. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium length, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

Remarks—This variety is entirely different from "Rubicunda Albomarginata" which is a dark red.

STANDARD BEARER.

Species — P. albiflora. *Originated by* Hollis, 1906.

Donated by Farr.

Description of bloom — Type of bloom bomb. Form of bloom globular, very compact. Differentiated. Entirely transformed. Color (total effect) violet rose 1 (154); guards clear; collar same as guards; center slightly flecked with scarlet. Fragrance pleasant XX. Blooming time early to mid-season. Large size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, very strong, green. Blooming habit free. Buds borne in clusters. Foliage well furnished, medium to light green, medium to fine size; veins green.

Commercial value—For cut bloom extra good; landscape value good. Variety as a whole extra good.

DANIEL D'ALBERT.

Red

Species — P. albiflora. *Origin* unknown.

Donated by Ellwanger & Barry.

Description of bloom — Type of bloom bomb. Form of bloom globular, medium compact. Not clearly differentiated. Not entirely transformed. Color (total effect) tyrian rose 2–3 (155); guards clear; collar same as guards; uniform color. Smooth, green carpels; pink stigmas; silver tipped. Fragrance pleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, medium size; veins green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

EDWIN FORREST.

Species — P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Description of bloom — Type of bloom bomb. Form of bloom globular, medium compact. Differentiated. Not entirely transformed. Color (total effect) 5 (168) dark crimson; guards streaked light; center same; secondary staminodes absent. Smooth, yellow carpels, pink stigmas. Fragrance nearly lacking. Blooming time mid-season to late. Medium size.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, medium strong, reddish green. Blooming habit free. Lateral buds undeveloped, healthy. Foliage medium furnished, light green, fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

SOUVENIR DE L'EXPOSITION DE BORDEAUX.

Species — P. albiflora. *Originated by* Dessert, 1896.

Donated by Kline.

Description of bloom — Type of bloom bomb. Form of bloom globular, medium compact. Differentiated. Not entirely transformed. Color (total effect) 4 (180) reddish violet; guards clear; center clear. Bloom has only slight silver tip, does not fade much in the sunlight. Fragrance unpleasant X. Blooming time mid-season. Medium to small size.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth medium to strong, healthy. Stem medium long, medium strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, fine; veins red.

Commercial value — For cut bloom medium; landscape value extra good. Variety as a whole good to extra good.

TRAGEDY.

Species — P. albiflora. *Originated by* Hollis, 1908.

Donated by Farr.

Description of bloom — Type of bloom bomb. Form of bloom globular, medium compact to loose. Differentiated. Entirely transformed. Color (total effect) dark crimson 5 (178); guards splashed light; collar same as guards; center clear. Very brilliant, dark variety, distinct shade. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, tall, compact. Growth strong. Stem medium long, medium to strong, reddish green. Blooming habit free. Lateral buds undeveloped, healthy. Foliage medium furnished, light green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

WASHINGTON.

Species — P. albiflora. *Originated by* Guerin, 1850.

Donated by Dessert.

Description of bloom — Type of bloom bomb. Form of bloom flat, medium compact. Differentiated. Not entirely transformed. Color (total effect) 1 (155) tyrian rose; collar lighter than guards; tinted cream at the base; center 1 (154) violet rose and silver tipped, clear. Yellowish carpels, pink stigmas. Same color as "General Bertrand" but more silver tipped. Fragrance pleasant XX. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, medium tall, medium compact. Growth strong and healthy. Stem medium long, strong, red. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, dark green, medium size; veins red.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

SEMI-ROSE TYPE

ALSACE LORRAINE.

White

Species — P. albiflora. *Originated by* Lemoine, 1906.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, compact. Not differentiated. Not entirely transformed. Color (total effect) cream white 1 (10), guards splashed slightly with crimson, collar same color as guards, center clear. Very attractive bloom. Fragrance unpleasant X. Blooming time late. Size large to very large.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong, healthy. Stem long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins red.

Commercial value — For cut bloom extra good; landscape value good. Variety as a whole extra good.

AURORE.

Species — P. albiflora. *Originated by* Dessert, 1904.

Donated by Cottage Gardens Company and Shaylor and Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) lilac white 1 (7), guards prominently flecked with crimson; collar milk white, lighter than guards; center flecked with crimson. The very center of the bloom is of the same shade as guards. Stamens very prominent, shown as well as in "La Rosière" or "Marguerite Gérard." Fragrance pleasant X. Blooming time late. Large size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong, healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds have laterals undeveloped, healthy. Foliage well furnished, medium green, fine in size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Remarks—This variety should not be confused with "Aurora" (Pleas), see Bulletin 278, page 237, nor "Aurora" (Hollis), see page 78.

BOULE DE NEIGE.

Species — P. albiflora. *Originated by* Calot, 1862.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom, semi-rose. Form of bloom medium globular, medium compact. Not differentiated. Not entirely transformed. Color (total effect) milk white; guards flecked noticeably crimson; collar same as guards; center flecked crimson, very striking. Fragrance unpleasant X. Blooming time early to mid-season. Very large to large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, coarse; veins green.

Commercial value — For cut bloom extra good; landscape value good. Variety as a whole good.

Remarks—Very similar to "Mons. Dupont," slightly more double, clearer white, and blooms 5–6 days ahead of "Dupont."

CLARA BARTON.

Species — P. albiflora. *Originated by* Terry.

Donated by Cottage Gardens Company and Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect) milk white; guards prominently flecked with crimson; center clear. Green carpels, pink stigmas. Bloom is single in weak plants. Fragrance unpleasant X. Blooming time early. Size large.

Description of plant — Habit of plant drooping, medium height, open. Growth medium. Stem medium long, weak, red. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium green, fine; veins red.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

JAMES KELWAY.

Species — P. albiflora. *Originated by* Kelway.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) 1 (8) rose white; guards prominently flecked with crimson; collar lighter than guards, fades milk white; center clear, central parts have yellow veins toward base. Fragrance unpleasant X. Blooming time mid-season. Very large size.

Description of plant — Habit of plant medium erect, medium height, medium compact. Growth medium to strong, healthy. Stem medium long to long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Remarks — Came from Peterson Nursery as such. Identical with "Lady Derby" from Shaylor and Thurlow, and "Mrs. Gwyn-Lewis" from Farr.

LE CYGNE.

Species — P. albiflora. *Originated by* Lemoine, 1907.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, compact. Not differentiated. Not entirely transformed. Color (total effect) pure milk white; collar same as guards; center clear. A few yellow stamens in center of bloom. Fragrance pleasant XX. Mid-season. Large size.

Description of plant — Habit of plant, erect, medium tall to tall, medium compact. Growth strong and healthy. Stem medium long, strong. Blooming habit medium free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value extra good to good. Variety as a whole good.

Remarks — The globular, compact type of bloom of this variety makes it easily distinguishable from other varieties.

MADAME DE TRÉYÉRAN.

Species — P. albiflora. *Originated by* Dessert, 1899.
Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, compact. Not differentiated. Not entirely transformed. Color (total effect) rose white 1 (8); guards splashed with scarlet; collar same as guards; center flecked with crimson. Color is splashed on giving a rose white tint. Very attractive. Fragrance pleasant XXX. Blooming time early. Size very large.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong. Stem medium long, strong, red. Blooming habit very free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium to fine in size; veins reddish green.

Commercial value — For cut bloom good; landscape value extra good. Variety as a whole good.

MARIE.

Species — P. albiflora. *Originated by* Calot, 1868.
Donated by Farr.

Description of bloom—Type of bloom semi-rose. Form of bloom flat, compact. Not differentiated. Not entirely transformed. Color (total effect) lilac white fading to milk white 2 (7); guards flecked with crimson; collar same as guards; center clear. Golden yellow 2 (16) staminodes, or short, narrow petals around the collar. Petals shading to yellow at base. Fragrance pleasant. Blooming time late. Medium size.

Description of plant — Habit of plant medium erect to erect, very tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters. Foliage medium furnished, dark green, medium size; veins red.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

USONA.

Species — P. albiflora. *Originated by* Hollis, 1907.
Donated by Hollis.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) lilac white 1 (7); guards flecked with crimson and green; center milk white, flecked. Stamens visible at center. Fragrance unpleasant XX. Blooming time mid-season. Very large size.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Stem strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, coarse; veins green.

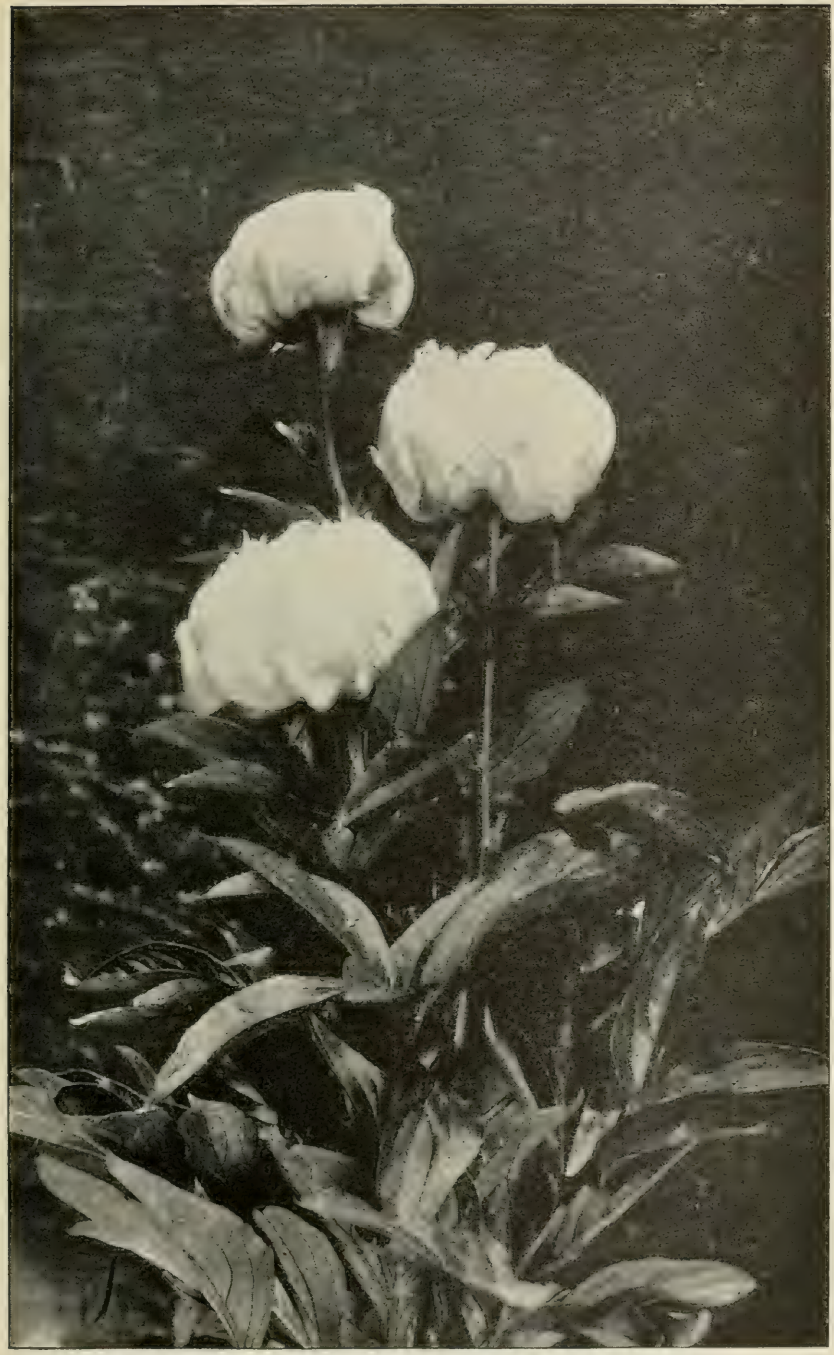
Commercial value — For cut bloom poor; landscape value good. Variety as a whole good.

MADEMOISELLE DESBUISSONS.

Pink and White

Species — P. albiflora. *Originated by* Crousse, 1893.
Donated by Goos and Koenemann.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, compact.



Marie Jacquin (semi-double type)

Not differentiated. Not entirely transformed. Color (total effect) pink and white; guards violet rose 1 (154); guards clear; center fades to milk white, clear. Stamens visible at center, small hairy carpels, white stigmas. Fragrance pleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit very free. Buds borne in clusters, healthy. Foliage well furnished, medium green, coarse; veins reddish green.

Commercial value — For cut bloom medium; landscape value extra good. Variety as a whole good.

ARSÈNE MEURET.

Pink

Species — P. albiflora. *Originated by* Verdier, 1854.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, medium compact. Not differentiated. Not entirely transformed. Color (total effect) violet rose 1 (154); guards violet rose, flecked with green, streaked light; collar same as guards; center clear; bloom silver tipped. Fragrance unpleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth strong, healthy. Stem medium long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium to fine size; veins green.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole medium to good.

BATTLEFIELD.

Species—P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, compact. Not differentiated. Not entirely transformed. Color (total effect) pure mauve 4 (181); guards flecked with crimson and green, splashed; center clear; secondary staminodes absent; silver-tipped imbricated bloom, uniform throughout. Fragrance unpleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant drooping, tall, open. Growth strong, healthy. Stem long, strong, reddish green. Blooming habit medium. Buds borne in clusters. Foliage poorly furnished, dark green, coarse; veins reddish green.

Commercial value — For cut bloom medium; landscape value poor. Variety as a whole medium to poor.

Remarks — Drooping habit makes it undesirable.

BÉLISAIRE.

Species — P. albiflora. *Originated by* Lemoine, 1907.

Donated by Farr.

Description of bloom—Type of bloom semi-rose. Form of bloom globular, medium compact. Not differentiated. Not entirely transformed. Color (total effect) pale lilac; guards very finely splashed with crimson; collar same as guards; center flecked with crimson. Splashed with minute dots of deeper lilac. Fragrance unpleasant X. Blooming time mid-season. Size medium to large.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth strong and healthy. Stem medium length, medium strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, medium size; veins red.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Remarks — Bloom is *identical* with "Asa Gray," the only difference in the two varieties being that "Bélisaire" has red stems, "Asa Gray" green.

BLANCHE DESSERT.

Species — P. albiflora. *Originated by* Dessert, 1888.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) solferino red 2 (157); guards clear; collar same as guards; center clear. Bloom attractive, somewhat imbricated. Fragrance unpleasant X. Blooming time early. Medium size.

Description of plant — Habit of plant drooping, medium tall, open. Growth medium, healthy. Stem medium length, weak, red. Blooming habit medium. Lateral buds undeveloped. Foliage poorly furnished, dark green, fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium to poor. Variety as a whole medium to poor.

Remarks — Wiry, weak stems, poorly furnished.

CARMEN.

Species — P. albiflora. *Originated by* Lemoine, 1898.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, compact. Not entirely differentiated. Not entirely transformed. Color (total effect) hydrangea pink 1 (132); guards clear; collar same as guards; center flecked with crimson. Color sprinkled on in fine dots like "Asa Gray." Fades lilac white. Fragrance unpleasant X. Blooming time mid-season. Very large size.

Description of plant—Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, red. Blooming habit medium. Buds single, healthy. Foliage medium furnished, light green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

CERISETTE.

Species—P. albiflora. *Origin* unknown.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, compact. Not differentiated. Not entirely transformed. Color (total effect) violet rose 3 (154); guards clear; collar same as guards; center flecked with green at base occasionally. Fragrance unpleasant X. Blooming time early to mid-season. Large size.

Description of plant—Habit of plant erect, medium tall, medium compact. Growth strong and healthy. Stem medium long, medium strength, reddish green. Blooming habit medium. Buds borne in clusters. Foliage well furnished, medium green, medium size; veins red.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

CHARLES TOCHÉ.

Species—P. albiflora. *Originated by* Dessert, 1888.

Donated by Farr.

Description of bloom — Type of bloom semi-double. Form of bloom globular, loose, stamens very noticeable. Not differentiated. Not entirely transformed. Color (total effect) violet rose 4 (154); guards clear; collar same as guards; center clear; color uniform. Fades in sun to 1 (154). Fragrance unpleasant XX. Blooming time early. Medium size.

Description of plant — Habit of plant erect, dwarf, compact. Growth strong and healthy. Stem short, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium to dark green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole good.

DUGUESCLIN.

Species — P. albiflora. *Originated by* Miellez, 1857.

Donated by Dessert.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, loose. Not differentiated. Not entirely transformed. Color (total effect) violet rose 4 (154); guards flecked with crimson; collar same as guards; center clear; secondary staminodes absent. Very prominently silver tipped. Petals noticeably serrate. Fragrance unpleasant X. Blooming time mid-season. Size medium to large.

Description of plant — Habit of plant medium erect, medium height, compact. Growth medium, healthy. Stem medium long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

ENCHANTMENT.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) pale lilac rose 1 (178); guards clear; collar same as guards; uniform color; secondary staminodes absent. Bloom fades in sunlight to hydrangea pink. Stamens plainly visible. Fragrance unpleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant drooping, medium height, medium compact. Growth strong and healthy. Stem long, strong, green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium green, coarse; veins green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor to worthless.

Remarks — Has no place in the trade.

EUGÉNIE VERDIER.

Species — P. albiflora. *Originated by* Calot, 1864.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, medium compact to loose. Not differentiated. Not entirely transformed. Color (total effect) 1 (132) hydrangea pink; guards clear; collar lighter than guards; very slight occasional crimson flecks on center. Color fades to lilac white. Fragrance pleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect, tall, open. Growth strong and healthy. Stem long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins red.

Commercial value — For cut bloom good; landscape value medium. Variety as a whole good.

Remarks — Much confused with "Eugene Verdier" and "Pottsi Alba."

GÉNÉRAL CAVAIGNAC.

Species — P. albiflora. *Originated by* Calot, 1858.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, compact. Not clearly differentiated. Entirely transformed. Color (total effect) light violet rose 1 (154); guards clear; collar same as guards; center splashed with crimson. Bloom tipped light. Fragrance pleasant X. Blooming time late. Size very large.

Description of plant—Habit of plant erect, tall, compact. Growth medium. Stem long, medium strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, fine; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

GEORGIANA SHAYLOR.

Species — P. albiflora. *Originated by* Shaylor, 1908.

Donated by Shaylor.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, compact. Not differentiated. Not entirely transformed. Color (total effect) 1 (129) pale rose pink; guards flecked with crimson, splashed slightly with crimson; collar same as guards; center flecked with crimson. First class certificate at Massachusetts Horticultural Society 1908. Fragrance pleasant X. Blooming time mid-season to late. Large size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

JAMES BLANC.

Species — P. albiflora. *Originated by* Crousse, 1883.

Donated by Cottage Gardens Company.

Description of bloom—Type of bloom semi-rose. Form of bloom flat, compact. Not differentiated. Not entirely transformed. Color (total effect) violet rose 3 (154); guards clear; collar same as guards; center clear. The distinguishing characteristic is deeply notched petals throughout bloom of about same width. Fragrance lacking. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, dark green, coarse; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

MADAME BARILLET DESCHAMPS.

Species — P. albiflora. *Originated by* Calot, 1868.

Donated by Farr.

Description of bloom—Type of bloom semi-rose. Form of bloom flat, imbricated. Not differentiated. Not entirely transformed. Color (total effect) violet rose 3 (154); guards clear; collar same as guards; center flecked occasionally with scarlet on edge. Bloom fades to a delicate silver pink in the sun. Fragrance pleasant X. Blooming time early to mid-season. Large size.

Description of plant — Habit of plant medium erect, medium height, medium compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, light green, coarse; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good to extra good.

MARY L. HOLLIS.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom—Type of bloom semi-rose. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) pale lilac rose 2 (178); guards clear; center clear, fades lilac white; secondary staminodes absent. Yellow stamens, plainly visible at center, concealed at collar. Fragrance unpleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, coarse; veins green.

Commercial value—For cut bloom medium; landscape value extra good. Variety as a whole good.

Remarks—A very attractive bloom.

NOBILISSIMA.

Species — P. albiflora. *Originated by* Miellez, 1858.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect)

4 (154) violet rose; guards clear; collar same as guards; center flecked with crimson. Fragrance unpleasant X. Blooming time mid-season to late. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, dark green, medium size; veins red.

Commercial value—For cut bloom medium; landscape value good. Variety as a whole good.

PETER PAN.

Species — P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) lilac rose 1 (152); guards flecked crimson; center prominently flecked crimson, fades lighter than guards. Bloom fades in sun to lilac white. Fragrance unpleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins green.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole medium.

PRAIRIE SPLENDOR.

Species—P. albiflora. *Originated by* Rosenfield.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Color (total effect) 2 (154) violet rose; guards clear; collar same as guards; center slightly flecked with crimson. Bloom silver tipped. Stamens may entirely disappear on very strong plants. Fragrance lacking. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, medium strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins red.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

REINE HORTENSE.

Species — P. albiflora. *Originated by* Calot, 1857.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, compact. Slightly differentiated. Not entirely transformed. Color (total effect) hydrangea pink 2 (132); guards splashed with crimson; collar same color as guards; center prominently flecked with crimson. Color splashed on rose white background. Fades in sunlight. Fragrance pleasant X. Blooming time early to mid-season. Very large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit medium. Buds borne in clusters. Foliage medium furnished, medium to dark green, medium size; veins reddish green.

Commercial value—For cut bloom good; landscape value medium. Variety as a whole good.

RUY BLAS.

Species — P. albiflora. *Originated by* Dessert.
Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) pure mauve 3 (181); guards clear; collar same as guards; center clear. Bloom fades rapidly, silver tipped. Fragrance unpleasant XXX. Blooming time mid-season. Medium size.

Description of plant—Habit of plant erect, dwarf, compact. Growth strong. Stem short, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, medium size; veins reddish green.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole medium.

SARAH BERNHARDT.

Species — P. albiflora. *Originated by* Lemoine, 1906.
Donated by Farr.

Description of bloom—Type of bloom semi-rose. Form of bloom flat, imbricated, compact. Not differentiated. Not entirely transformed. Color (total effect) mauve rose 2 (153); guards clear; collar same as guards; center clear. Bloom silver tipped. Fragrance pleasant X. Blooming time late. Size large to very large.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong. Stem long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins green.

Commercial value—For cut bloom extra good; landscape value good. Variety as a whole extra good.

Remarks — This variety should not be confused with the so-called "Sarah Bernhardt" (Dessert) which is really "Umbellata Rosea." See page 292, Bulletin 278.

TROJAN.

Species — P. albiflora. *Origin* unknown.
Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) crimson pink 1 (150); guards flecked with scarlet and green; collar same color as guards; center slightly flecked with crimson and white; secondary staminodes absent. Bloom silver tipped. Fragrance unpleasant XX. Blooming time mid-season. Medium to large size.

Description of plant—Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins green.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole good.

WALTER FAXON.

Species — P. albiflora. *Originated by* Richardson.
Donated by Shaylor.

Description of bloom—Type of bloom semi-rose. Form of bloom globular, medium compact. Differentiated. Not entirely transformed. Color (total effect) bright rose 2 (128); guards clear; center clear; uniform color throughout. Guard petals fade lighter than center. Very delicate color. Fragrance slight. Blooming time mid-season. Medium size.

Description of plant—Habit of plant medium erect, medium tall, medium compact. Growth medium strong, healthy. Stem medium long, medium strong, green. Blooming habit medium to free. Foliage medium to dark green; veins reddish green.

Commercial value — For cut bloom good; landscape value medium. Variety as a whole good.

ADMIRAL TOGO.

Red

Species—P. albiflora. *Originated by* Hollis, 1907.
Donated by Farr and Hollis.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) crimson carmine 6–7 (159); guards clear; collar same as guards; center clear. Holds color well (no silver tips). Fragrance unpleasant XX. Blooming time mid-season. Size medium to large.

Description of plant — Habit of plant erect, medium tall, compact. Growth medium strong, healthy. Stem medium long, strong, reddish green. Blooming habit medium free. Buds borne in clusters, healthy. Foliage well furnished, very dark green, medium fine; veins red.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

AKSARBEN.

Species — P. albiflora. *Originated by* Rosenfield, 1908.
Donated by Farr.

Description of bloom—Type of bloom semi-rose. Form of bloom flat, compact. Not differentiated. Not entirely transformed. Color (total effect) dark crimson 4–5 (168); guards clear; collar same as guards; center, green streaks in carpelodes. Fragrance unpleasant X. Blooming time mid-season. Size large.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong, healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, dark green, medium fine; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Remarks—Somewhat like "Karl Rosenfield," but foliage not as coarse, bloom more compact, with green streaks in center.

AUGUSTE GAUTHIER.

Species—P. albiflora. *Originated by* Dessert and Mechin, 1890.
Donated by Cottage Gardens Company.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, medium compact. Not differentiated. Not entirely transformed. Color (total effect) tyrian rose 4 (155); guards clear; collar same as guards; center clear; secondary staminodes absent. Noticeably silver tipped, imbricated, wide petals throughout. Fragrance unpleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, medium strength, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole good.

BISMARK.

Species — P. albiflora. *Origin* unknown.
Donated by Charlton.

Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) magenta 4 (182); guards clear; collar same as guards; center clear; secondary staminodes absent. Fragrance unpleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, medium strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage poorly furnished, medium to light green, fine; veins red.

Commercial value—For cut bloom poor; landscape value poor. Variety as a whole poor.

Remarks — Absolute identity is not established.

CAVALLERIA RUSTICANA.

Species — P. albiflora. *Originated by* Kelway.
Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, medium compact. Not entirely differentiated. Not entirely transformed. Color (total effect) reddish violet 4 (168); guards have light streak in center; collar same color as guards; center clear; uniform color. Wide petals throughout bloom. Fragrance unpleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, medium tall, medium compact to compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, dark green, medium size; veins red.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

COQUELIN.

Species — P. albiflora. *Originated by* Dessert.
Donated by Farr.

Description of bloom — Type of bloom semi-double. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) tyrian rose

1 (155); guards clear; collar same as guards; center clear. Bloom becomes silver tipped with age. Stamens visible at collar and center. Fragrance unpleasant XX. Blooming time early. Medium size.

Description of plant — Habit of plant drooping, dwarf to medium, medium compact. Growth medium strong, healthy. Stem short to medium length, weak to medium strong, red. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins red.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

E. G. HILL.

Species — P. albiflora. *Originated by* Lemoine, 1906.

Donated by Farr.

Description of bloom—Type of bloom semi-rose. Form of bloom medium globular, compact. Slightly differentiated. Not entirely transformed. Color (total effect) tyrian rose 2 (155); uniform color; center 2 (155), clear. Very showy, desirable bloom. Stamens nearly concealed. Fragrance unpleasant X. Blooming time early. Size large to very large.

Description of plant — Habit of plant erect, dwarf, compact. Growth strong and healthy. Stem short, strong, green. Blooming habit free. Lateral buds undeveloped, healthy Foliage medium furnished, medium green, medium size; veins green.

Commercial value — For cut bloom good; landscape value extra good. Variety as a whole extra good.

GÉNÉRAL DODDS.

Species — P. albiflora. *Originated by* Crousse, 1893.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, very compact. Slightly differentiated. Entirely transformed. Color (total effect) dark tyrian rose 4 (155); guards splashed with green; collar same as guards; center clear. A few small, pure white petals around the center. Fragrance lacking. Blooming time late. Size very large.

Description of plant — Habit of plant erect, tall, compact. Growth strong. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium to light green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

GENERAL HOOKER.

Species — P. albiflora. *Originated by* Terry.

Donated by Farr

Description of bloom — Type of bloom semi-rose. Form of bloom flat, compact. Not differentiated. Not entirely transformed. Color (total effect) 4 (155) tyrian rose; guards flecked; collar same as guards; center clear; uniform color throughout. Bloom has slight silver tip. Fragrance unpleasant XX. Blooming time mid-season. Size large.

Description of plant — Habit of plant medium erect, medium tall to tall, medium compact. Growth medium to strong, healthy. Stem long, medium strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

GEORGE WASHINGTON.

Species—P albiflora. *Originated by* Hollis, 1904.
Donated by Farr

Description of bloom—Type of bloom semi-rose. Form of bloom flat, loose. Not differentiated. Not entirely transformed. Color (total effect) 4 (168) dark crimson, guards clear, collar same as guards; center clear, uniform color. Fragrance unpleasant XXX. Blooming time mid-season. Large size.

Description of plant—Habit of plant erect, medium height, medium compact. Growth strong and healthy. Stem medium to long, strong, red. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins vivid red.

Commercial value—For cut bloom poor; landscape value medium. Variety as a whole medium.

Remarks—Much like numerous other red semi-doubles. Not to be confused with "Washington" (Guerin, 1860).

KARL ROSENFIELD

Species—P. albiflora. *Originated by* Rosenfield, 1908.
Donated by Farr and Rosenfield.

Description of bloom—Type of bloom semi-rose. Form of bloom globular, compact. Not differentiated. Not entirely transformed. Color (total effect) 4–5 (168) dark crimson; guards clear; collar same as guards; center clear. Fragrance lacking. Blooming time mid-season. Size large to very large.

Description of plant—Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters. Foliage well furnished, dark green, coarse; veins green.

Commercial value—For cut bloom good; landscape value good. Variety as a whole very good Keeps unusually well as a cut flower. One of the best crimson varieties in the trade.

MADAME ADRIEN SÉNÉCLAUZE.

Species—P. albiflora. *Originated by* Sénéclauze, 1875.
Donated by Dessert.

Description of bloom—Type of bloom semi-rose. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) 1 (169) rose magenta; guards streaked light; collar lighter than guards; center clear; secondary staminodes absent. Bloom fades somewhat on tips with age. Fragrance unpleasant XX. Blooming time mid-season. Large size.

Description of plant—Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, coarse, veins reddish green.

Commercial value—For cut bloom poor; landscape value medium. Variety as a whole medium.

MADAME AUGUSTE DESSERT.

Species — P. albiflora. *Originated by* Dessert, 1899.

Donated by Shaylor.

Description of bloom — Type of bloom semi-rose. Form of bloom medium globular, medium compact. Color (total effect) 1 (154) violet rose; guards slightly flecked with crimson; collar same as guards; center flecked with crimson. Fragrance unpleasant XX. Blooming time early to mid-season. Very large to large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

MADAME MOUTOT.

Species — P. albiflora. *Originated by* Crousse, 1892.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Color (total effect) 2 (155) tyrian rose; guards clear; collar same as guards; center clear. Bloom fades slight silver tipped. Fragrance pleasant XX. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, medium height, compact. Growth medium strong. Cornell specimens diseased. Stem medium long, medium strong, red. Blooming habit shy; this may be on account of disease. Buds single, blight. Foliage medium furnished, light green, medium size; veins vivid red.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

NIGRICANS.

Species — P. albiflora. *Origin* unknown.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, medium compact. Not differentiated. Not entirely transformed. Color (total effect) dark crimson; uniform color throughout 5 (168); center clear. Very deep, rich color. Fragrance unpleasant X. Blooming time mid-season to late. Medium size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, red. Blooming habit irregular. Buds borne in clusters. Foliage medium furnished, dark green, medium size; veins vivid red.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole good.

PIERRE REIGNOUX.

Species — P. albiflora. *Originated by* Dessert, 1908.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom medium flat, medium to compact. Not differentiated. Not entirely transformed. Color (total effect) tyrian rose 1 (155); guards clear; collar 1 (155) same as guards; center slightly flecked with crimson. Imbricated, very attractive bloom. Fades out in sun; a few stamens seen in center of bloom. Fragrance unpleasant X. Blooming time early. Large size.

Description of plant — Habit of plant medium erect to drooping, dwarf, medium compact. Growth medium strong, healthy. Stem short, medium strong to weak, red. Blooming habit medium to free. Lateral buds undeveloped. Foliage medium furnished, medium green, fine size; veins reddish green.

Commercial value — For cut bloom poor; landscape value good. Variety as a whole good.

RAPHAEL.

Species — P. albiflora. *Originated by* Mechin, 1882.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom globular, medium compact to loose; stamens visible. Not differentiated. Not entirely transformed. Color (total effect) purple garnet 5-6 (165); guards streaked light; center has occasionally light streak. Very desirable, dark red for early season. Fragrance unpleasant X. Blooming time extra early. Medium size.

Description of plant — Habit of plant erect, dwarf, compact. Growth strong and healthy. Stem short, strong, vivid red. Blooming habit very free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins red.

Commercial value — For cut bloom poor; landscape value good to extra good. Variety as a whole good.

ROSSINI.

Species — P. albiflora. *Originated by* Kelway.

Donated by Farr.

Description of bloom—Type of bloom semi-rose. Form of bloom flat, imbricated, medium compact. Not differentiated. Not entirely transformed. Color (total effect) tyrian rose 4 (155), silver tipped; guards clear; collar same as guards; center clear. Stamens are concealed; bloom fades quickly in the sun. Fragrance unpleasant XX. Blooming time early to mid-season. Medium size.

Description of plant — Habit of plant erect, medium tall, medium compact. Growth strong and healthy. Stem medium length, medium strength, red. Blooming habit medium to free. Buds borne in clusters, healthy. Foliage medium furnished, dark green, medium size; veins red.

Commercial value — For cut bloom medium to good; landscape value good. Variety as a whole good.

SAMOSET.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom—Type of bloom semi-rose. Form of bloom flat, medium compact to compact. Not differentiated. Not entirely transformed. Color (total effect) rose magenta 1 (169); guards streaked light; center clear, slightly silver tipped. This is a showy bloom. Fragrance unpleasant XX. Blooming time early to mid-season. Very large size.

Description of plant — Habit of plant very erect, tall, compact. Growth strong and healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, coarse; veins reddish green.

Commercial value — For cut bloom medium; landscape value extra good. Variety as a whole good.

Remarks--This is a very promising variety.

SENATOR.

Species — P. albiflora. *Originated by* Terry.

Donated by Farr.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, imbricated, medium compact. Not differentiated. Not entirely transformed. Color (total effect) reddish violet 4 (180); guards streaked light; collar same as guards; center clear; secondary staminodes absent. A few stamens partly visible in the center of the bloom. Fragrance unpleasant XX. Blooming time early to mid-season; size very large.

Description of plant—Habit of plant medium erect to drooping, tall, medium to open. Growth strong and healthy. Stem long, medium strong to strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium to coarse in size; veins reddish green.

Correction to Bulletin 259 — The above description is much better for this variety.

TENIERS.

Species — P. albiflora. *Originated by* Crousse, 1880.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom semi-rose. Form of bloom flat, medium compact. Not differentiated. Not entirely transformed. Color (total effect) purple garnet 5 (165); guards streaked light; collar same as guards; center silver tipped, slightly streaked light; uniform color. Fragrance unpleasant X. Blooming time mid-season. Medium size.

Description of plant— Habit of plant medium erect, medium tall to dwarf, compact. Growth strong and healthy. Stem medium long, strong, red. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole medium.

Correction to Bulletin 259—The above description is much better for this variety.

ROSE TYPE

BARONESS SCHROEDER.

White

Species—P. albiflora. *Originated by* Kelway.

Donated by Farr, Shaylor, Rosenfield, Cottage Gardens Company, Perennial Gardens, Ellwanger & Barry, Blue Hill Nursery.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Not entirely transformed. Color (total effect) flesh white fading to milk white; guards clear; collar same as guards; center clear. Fragrance pleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, tall, compact. Growth strong. Stem long, strong, reddish green. Free blooming. Lateral buds undeveloped, healthy. Foliage well furnished, medium green, medium size; green veins.

Commercial value — For cut bloom extra good; landscape value good. Variety as a whole extra good.

CARNEA STRIATA.

Species — P. albiflora. *Origin* unknown.

Donated by Jackson and Perkins.

Description of bloom — Type of bloom rose. Form of bloom globular, medium compact. Slightly differentiated. Entirely transformed. Color (total effect) lilac white; guards clear; collar same as guards; center flecked with crimson; secondary staminodes absent. Fragrance pleasant X. Blooming time mid-season. Medium to large size.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth strong and healthy. Stem medium long, medium strength, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, fine; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

CLAUDE GELÉE.

Species — P. albiflora. *Originated by* Lemoine.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) 1 (10) creamy white; guards clear; collar same as guards; center clear; secondary staminodes absent. Occasional faint crimson fleck on center petals. Fragrance pleasant X. Blooming time late. Size large.

Description of plant — Habit of plant medium erect, dwarf to medium compact. Growth medium strong, stem medium long, medium strong. Blooming habit medium. Buds single, occasional side buds. Foliage medium furnished, medium green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Remarks — Color effect and type of bloom same as "Alsace Lorraine" but much more dwarf and a few days later.

DOROTHY E. KIBBY.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

This so-called variety cannot be distinguished from "Couronne d'Or."

Synonym — "Couronne d'Or."

EMMCHEN.

Species — P. albiflora. *Origin* unknown.

Donated by Goos and Koenemann.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) milk white; guards clear; collar same as guards; center clear; secondary staminodes present. Fragrance unpleasant X. Blooming time late. Size large.

Description of plant—Habit of plant erect, medium tall to tall, compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, coarse; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

ENCHANTRESSE.

Species — P. albiflora. *Originated by* Lemoine.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) 1 (10) creamy white; guards splashed with scarlet; collar same color as guards; center faintly flecked with crimson. Fragrance pleasant X. Blooming time very late. Very large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good to extra good.

GRANDIFLORA (RICHARDSON).

Species — P. albiflora. *Originated by* Richardson and Hovey, 1883.

Donated by Cottage Gardens Company and Farr.

Description of bloom — Type of bloom rose. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) 2 (7) rose white; guards clear; collar same as guards; center clear. Fragrance pleasant XX. Blooming time late. Very large size.

Description of plant — Habit of plant medium erect, tall, open. Growth strong and healthy. Stem long, medium strong, green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium to fine in size; veins red.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

HUMEI ALBA.

Species — P. albiflora. *Originated by* Lemon, 1830.

Donated by Cottage Gardens Company.

Description of bloom—Type of bloom rose. Form of bloom flat, loose. Not differentiated. Entirely transformed. Color (total effect) lilac white 1 (7); guards clear; collar same as guards; center clear. Fragrance pleasant XX. Blooming time early. Large size.

Description of plant — Habit of plant medium erect, medium height, medium compact. Growth medium strong, healthy. Stem medium long, medium strong, green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, light green, fine; veins green.

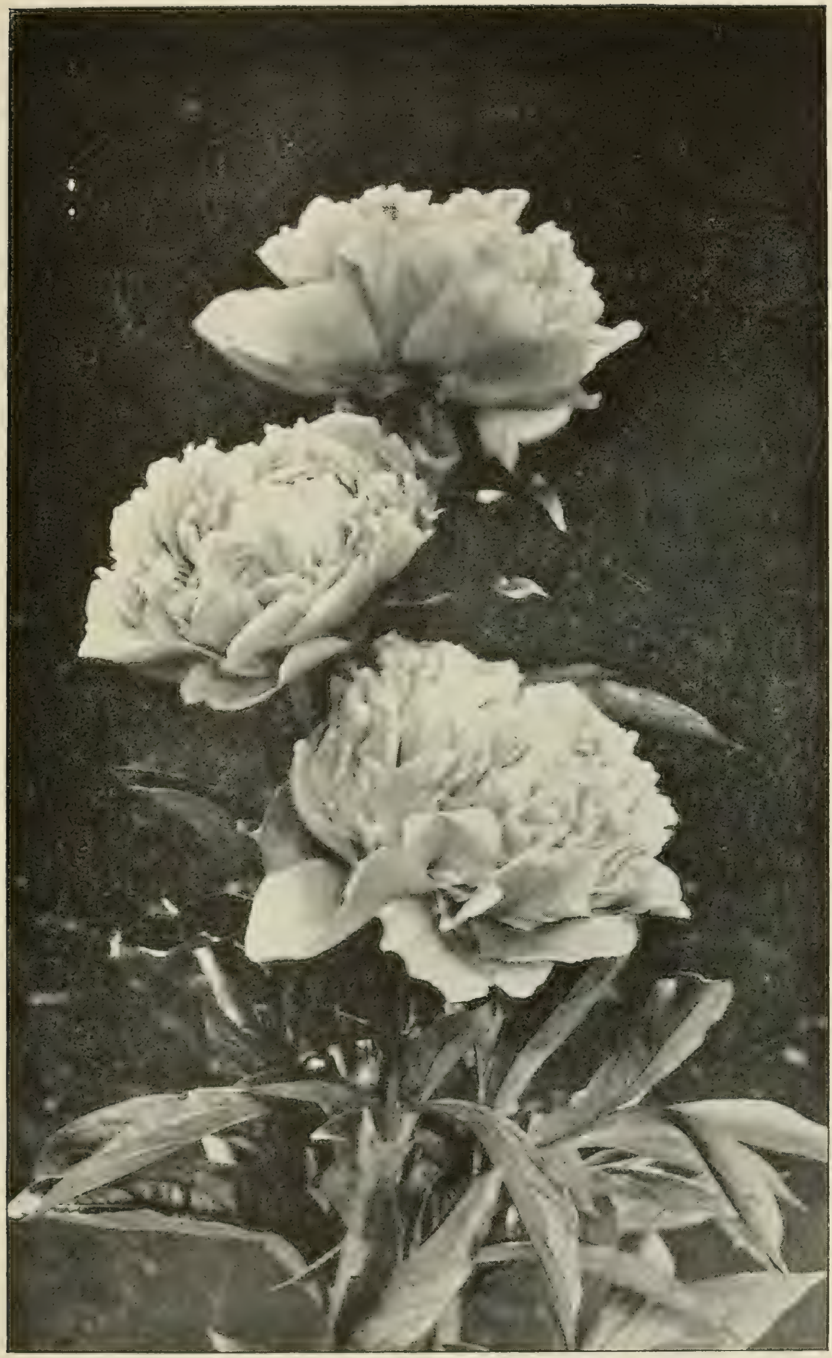
Commercial value — For cut bloom good; landscape value medium. Variety as a whole good.

LADY DARMOUTH.

Species — P. Albiflora. *Origin* unknown, 1850.

Donated by Farr.

Description of bloom—Type of bloom rose. Form of bloom flat, loose. Slightly differentiated. Entirely transformed. Color (total effect) milk white; guards clear; collar cream white; center flecked with green. Petals of all sizes mixed throughout bloom. Fragrance pleasant X. Blooming time early. Small size.



Lamartine (rose type as grown at the Cottage Gardens nurseries)

Description of plant — Habit of plant erect, medium height, medium compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

LA FRANCE.

Species—P. albiflora. *Originated by* Lemoine, 1901.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) rose white 3 (8); guards splashed with crimson; collar same as guards; center clear; bloom uniform color throughout; secondary staminodes absent. The outer guard petals have a splash of crimson through the center deepening at the base. Fragrance very pleasant XX. Blooming time mid-season to late. Very large size.

Description of plant — Habit of plant erect, medium tall to tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom extra good; landscape value extra good. Variety as a whole extra good.

Remarks — Very distinct variety. Perfect rose type.

LA TENDRESSE.

Species — P. albiflora. *Originated by* Crousse, 1896.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) milk white; guards slightly splashed; center flecked with crimson. Flecks are very prominent on some blooms, very slight on others. Fragrance pleasant X. Blooming time early. Size medium to large.

Description of plant — Habit of plant erect, medium tall, medium compact to open. Growth medium strong, healthy. Stem medium long, medium strong to strong, reddish green. Blooming habit free. Buds borne in clusters. Foliage medium furnished; medium green, medium size; veins reddish green.

Commercial value — For cut bloom extra good; landscape value good. Variety as a whole good.

LUCY E. HOLLIS.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) lilac white 1 (7); guards clear; collar same as guards; center slightly flecked with scarlet; secondary staminodes present. Center of bloom shaded to pale lilac rose 1 (178). Fragrance pleasant X. Blooming time very late. Large size.

Description of plant — Habit of plant drooping, not good, medium height, medium compact. Growth strong and healthy. Stem medium long, medium strong to weak, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, coarse; veins green.

Commercial value—For cut bloom medium; landscape value poor. Variety as a whole medium to poor.

Remarks — Undesirable bud like "Charlemagne."

MADAME ÉMILE GALLÉ.

Species — P. albiflora. *Originated by* Crousse, 1881.

Donated by L. Paillet.

Description of bloom—Type of bloom rose. Form of bloom flat, compact. Not differentiated. Color (total effect) 2 (7) lilac white; guards clear; center clear; secondary staminodes present. Fine formed, attractive bloom, center fades with age to milk white. Fragrance pleasant X. Blooming time midseason to late. Large size.

Description of plant — Habit of plant medium erect, medium tall to tall, compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium to light green, medium size; veins reddish green.

Commercial value — For cut bloom extra good; landscape value good. Variety as a whole good to extra good.

Correction to Bulletin 259 — The above description is much better for this variety.

MADAME FOULD.

Species — P. albiflora. *Originated by* Crousse, 1893.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) milk white; guards clear; center lilac white, very slightly flecked with crimson. Fragrance pleasant X. Blooming time very late. Large size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, very strong, green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium green, coarse; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Remarks — Very tight bud, too full; apt to burst and become waterlogged.

MADAME VILMORIN.

Species — P. albiflora. *Originated by* Guerin, 1866.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom only medium globular. Not differentiated. Entirely transformed. Color (total effect) rose white 2 (8); guards clear; collar same as guards; center splashed with rose. Bloom shading to amber at base of petals. Occasional narrow petals intermixed. Fragrance very pleasant XX. Blooming time late. Medium size.

Description of plant — Habit of plant medium erect, medium height, medium compact. Growth medium strong. Stem medium long, medium strong, green.

Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins red.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

MADEMOISELLE MARIE CALOT.

Species—P. albiflora. *Originated by* Calot, 1872.

Donated by Farr, Cottage Gardens Company, and Goos and Koenemann.

Description of bloom — Type of bloom rose. Form of bloom globular, medium compact. Not differentiated. Entirely transformed. Color (total effect) milk white; guards clear; center usually slightly flecked with crimson. Very poor, loose blooms are produced until clump is well established for 4-5 years. Fragrance pleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, coarse; veins reddish green.

Commercial value—For cut bloom medium; landscape value medium. Variety as a whole medium.

MARIE DEROUX.

Species — P. albiflora. *Originated by* Crousse, 1881.

Donated by Cottage Gardens Company.

Description of bloom—Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) lilac white 2 (7); guards prominently flecked with crimson; collar lighter than guards; center clear. Fragrance pleasant X. Blooming time late. Large size.

Description of plant — Habit of plant medium erect, tall, open. Growth strong and healthy. Stem long, medium strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

MARY A. LIVERMORE.

Species—P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) milk white; guards slightly flecked crimson, clear; collar same as guards; center clear; secondary staminodes present. Fragrance pleasant X. Blooming time late. Large size.

Description of plant — Habit of plant medium erect, medium tall to tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, dark green, coarse; veins red.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

MONT BLANC.

Species — P. albiflora. *Originated by* Lemoine, 1899.

Donated by Cottage Gardens Company.

Description of bloom—Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) milk white; guards slightly flecked with crimson; collar same as guards; center clear, slight rose white tint. Blooms larger than "Festiva Maxima." One of the very best varieties in the trade. Very distinct and much superior to the "Mont Blanc" ("Solfatare") which is usually found under this name. Fragrance pleasant XXX. Blooming time early to mid-season. Very large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, very strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, dark green to medium green, coarse; veins green.

Commercial value — For cut bloom extra good; landscape value extra good. Variety as a whole extra good.

PARADISE.

Species—P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom—Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) lilac white; guards hydrangea pink 1 (132); guards slightly streaked; center occasionally flecked, fades milk white; secondary staminodes present. Fragrance pleasant X. Blooming time early to mid-season. Large size.

Description of plant—Habit of plant medium erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value—For cut bloom good; landscape value good. Variety as a whole good.

SNOWBALL.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom—Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) milk white; guards slightly splashed; collar same color as guards; center clear, milk white; secondary staminodes present. Fragrance pleasant X. Blooming time mid-season. Small size.

Description of plant — Habit of plant medium erect, dwarf, compact. Growth strong and healthy. Stem medium long to short, medium strong to weak, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, dark green, fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole worthless.

VERIBEST.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom medium globular, medium compact. Not differentiated. Entirely transformed. Color (total effect) milk white; guards slightly splashed; collar same color as guards;

center clear; secondary staminodes present. Very undesirable bud; worse than "Charlemagne." Fragrance pleasant XX. Blooming time very late. Medium size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong, diseased. Stem medium long, strong, green. Blooming habit medium to shy. Buds borne in clusters, blighted. Foliage well furnished, dark green, medium size; veins green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor to worthless.

GEORGE HOLLIS.

Pink and White

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom globular, medium compact. Not differentiated. Entirely transformed. Color (total effect) pale rose pink; guards 1 (7) lilac white, flecked with crimson; collar same as guards; center 1 (129) pale rose pink, clear; secondary staminodes present. Very attractive, full double bloom. Fragrance pleasant X. Blooming time very late. Large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

HAPPY DAY.

Species — P. albiflora. *Originated by* Hollis, 1908.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) pink and white; guards 4 (154) violet rose, streaked; center lilac white, prominently flecked and streaked with crimson; secondary staminodes present. Bloom fades. Fragrance pleasant X. Blooming time mid-season. Very large size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, dark green, coarse; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

QUEEN EMMA.

Species — P. albiflora. *Origin* unknown.

Donated by Wild.

Description of bloom — Type of bloom rose. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) pale lilac rose and cream; guards pale lilac, flecked with green; collar cream white and lilac; center clear; secondary staminodes present. Entire bloom is intermixed with cream petals. Fragrance pleasant X. Blooming time mid-season. Size medium.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, medium strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, fine; veins reddish green.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole medium to good.

AUGUSTE VILLAUME.

Pink

Species — P. albiflora. *Originated by* Crousse, 1895.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) violet rose 4 (154); uniform color throughout; guards clear, collar same as guards; center clear. Very full, extra large bloom with a few short narrow petals near the center. Not a first-class bud. Fragrance pleasant X. Blooming time late. Large size.

Description of plant — Habit of plant erect, tall, medium compact. Growth strong. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, coarse to medium in size; veins red.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

BELLE DOUAISIENNE.

Species — P. albiflora. *Originated by* Calot, 1861.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Color (total effect) hydrangea pink 1 (132); guards clear; center prominently flecked with crimson. Uniform color. Fades to lilac white. Fragrance pleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant drooping, medium height, open. Growth strong, healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters. Foliage medium to poorly furnished, medium green, coarse; veins reddish green.

Commercial value — For cut bloom good; landscape value poor. Variety as a whole medium.

BELLE OF FRANCE.

Species — P. albiflora. *Origin* unknown.

Donated by Charlton.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) violet rose 1 (154); guards clear; collar same as guards; center flecked; secondary staminodes absent. Intermixed with linear petals. Fragrance pleasant XX. Blooming time mid-season. Size large.

Description of plant — Habit of plant medium erect, medium to tall, compact. Growth strong and healthy. Stem medium to long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium to light green, medium size; veins green to reddish green.

Commercial value—Extra good for cut bloom; landscape value good. Variety as a whole good.

Remarks — Identity questionable.

BELLE MAUVE.

Species — P. albiflora. *Originated by* Lemoine, 1903.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Slightly differentiated. Entirely transformed. Color (total effect) pale lilac rose 1-4 (130); guards clear; collar same as guards; center clear. Uniform color. Fades to noticeable silver tip. Fragrance pleasant XXX. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect to tall, medium compact. Growth strong, healthy. Stem long, strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, medium size; veins red.

Commercial value—For cut bloom medium; landscape value medium. Variety as a whole medium.

BERANGER.

Species — P. albiflora. *Originated by* Dessert, 1895.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom rose. Form of bloom very flat, medium compact. Color (total effect) violet rose 2 (154); guards clear; collar same as guards; center clear. Fragrance pleasant XX. Blooming time very late. Medium size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, medium strength, reddish green. Blooming habit medium. Buds borne in clusters. Foliage medium furnished, dark green, coarse; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

CARNEA ELEGANS.

Species — P. albiflora. *Originated by* Guerin, 1850.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) hydrangea pink 1 (132); guards clear; collar same as guards; center clear. Red stigmas. Fragrance pleasant XXX. Blooming time mid-season. Size small to medium.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth medium strong. Stem medium long, medium strong, green. Blooming habit free. Buds borne in clusters. Foliage medium furnished, light green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Remarks—This variety should not be confused with "Carnea Elegans" (Calot), Bulletin 278, page 262.

Correction to Bulletin 278—The description in the above publication is the Calot sort and not Guerin's as printed.

CHARLOTTE CUSHMAN.

Species — P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) solferino red 1 (157); guards flecked; center clear. Color uniform. Secondary staminodes present. Fragrance pleasant X. Blooming time late. Size large.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished to poor, light green, coarse; veins green.

Commercial value — For cut bloom medium; landscape value poor to medium. Variety as a whole medium.

CHRISTINE RITCHER.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) 2 (154) violet rose; guards slightly flecked; center clear; color uniform throughout; secondary staminodes present. Fragrance unpleasant X. Blooming time late. Size medium to small.

Description of plant — Habit of plant medium to erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, light green, coarse; veins reddish green.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole medium to good.

CLAIRE DUBOIS.

Species — P. albiflora. *Originated by* Crousse, 1886.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom globular. Not differentiated. Entirely transformed. Color (total effect) 4 (154) violet rose; guards clear; collar same as guards; center clear; secondary staminodes absent. The petals are tipped silvery white. Fragrance unpleasant. Blooming time late. Size very large.

Description of plant — Habit of plant erect, tall, compact. Growth strong. Stem long, strong, green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins green.

Commercial value—For cut bloom extra good; landscape value extra good. Variety as a whole extra good.

CLARA HERSEY.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) 4 (154) violet rose; guards clear; collar same as guards; center clear; secondary staminodes present. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant drooping, medium tall, medium compact. Growth medium, healthy. Stem medium long, weak, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

Remarks — Not very attractive.

CONQUERER.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom—Type of bloom rose. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) lilac rose 1 (152); guards streaked light; collar same as guards; center clear; secondary staminodes present. Bloom fades somewhat in sun. Fragrance pleasant X. Blooming time mid-season. Large size.

Description of plant—Habit of plant erect to medium erect, very tall, medium compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, coarse; veins green.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole medium to good.

DUKE OF DEVONSHIRE.

Species — P. albiflora. *Originated by* Kelway, 1896.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom rose. Form of bloom flat, compact. Differentiated. Not entirely transformed. Color (total effect) solferino red 3 (157); guards clear; collar same as guards; center clear; uniform color. Narrow petals found scattered through the bloom. Fragrance pleasant X. Blooming time late. Size very large.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom medium; landscape value extra good. Variety as a whole good.

EDMOND ABOUT.

Species — P. albiflora. *Originated by* Crousse, 1885.

Donated by L. Paillet.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) hydrangea pink 1 (132); guards hydrangea pink; center a tint darker than the guards; some blooms very prominently flecked with crimson. Extra well made bloom. Fragrance pleasant XX. Blooming time mid-season to late. Size large.

Description of plant — Habit of plant medium to erect, medium tall, compact. Growth strong and healthy. Stem medium long, very strong, green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

Remarks — This variety seemed to thrive much better at Cornell than under the average nursery conditions elsewhere. In fact many growers have found this a very poor bloomer.

ETTA.

Species — P. albiflora. *Originated by* Terry.

Donated by Farr and Thurlow.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact to loose. Not differentiated. Entirely transformed. Color (total effect) hydrangea pink 1 (132); guards clear; collar same as guards; center clear; uniform color. Fragrance pleasant XX. Blooming time very late. Size medium.

Description of plant — Habit of plant medium erect to drooping, medium height, medium compact. Growth medium, healthy. Stem medium long, medium to weak, green. Blooming habit medium to shy. Lateral buds undeveloped, blight. Foliage medium furnished, medium to light green, fine; veins green.

Commercial value — For cut bloom good; landscape value medium. Variety as a whole medium to good.

GOODSPEED.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) 4 (154) violet rose; guards clear; collar same as guards; center clear; uniform color throughout. Bloom silver tipped. Fragrance pleasant X. Blooming time midseason. Medium size.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, weak, reddish green. Blooming habit medium. Lateral buds undeveloped, healthy. Foliage medium to poorly furnished, dark green, fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

HENRI MURGER.

Species — P. albiflora. *Originated by* Crousse, 1895.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) 1 (181) pure mauve; guards clear; collar same as guards; center clear; secondary staminodes absent. Fragrance pleasant XX. Blooming time late. Size very large.

Description of plant — Habit of plant erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, green. Blooming habit free. Buds single, healthy. Foliage medium furnished, medium green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

IRMA.

Species — P. albiflora. *Originated by* Calot, 1859.
Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) violet rose 3 (154); guards clear; collar same as guards; center clear; secondary staminodes absent. A few cream yellow, small petals at the center. Fragrance lacking. Blooming time late. Very large size.

Description of plant — Habit of plant erect, medium height, compact. Growth strong. Stem medium long, very strong, green. Blooming habit free. Buds borne in clusters. Foliage well furnished, light green, coarse; veins green.

Commercial value—For cut bloom good; landscape value good. Variety as a whole good.

JESSIE K. CROSBY.

Species—P. albiflora. *Originated by* Hollis, 1907.
Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom tall, compact. Differentiated. Entirely transformed. Color (total effect) hydrangea pink, fades to lilac white; collar same as guards; center same; secondary staminodes present. Bloom is intermixed with narrow petals. Center forms hollow, cup-shaped. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant, erect, tall, compact. Growth strong and healthy. Stem very long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, coarse; veins reddish green.

Commercial value—For cut bloom poor; landscape value medium. Variety as a whole medium to poor.

KELWAY'S QUEEN.

Species — P. albiflora. *Originated by* Kelway.
Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) mauve rose 2 (153); guards clear; collar same as guards; center flecked with crimson; secondary staminodes present. Fragrance pleasant X. Blooming time mid-season to late. Large size.

Description of plant — Habit of plant erect, tall, compact. Growth strong. Stem long, strong, reddish green. Blooming habit free. Lateral buds undeveloped, healthy. Foliage well furnished, medium green, medium size; veins red.

Commercial value — For cut bloom good; landscape value extra good. Variety as a whole extra good. This is distinct from "The Queen" (Kelway).

LOST TREASURE.

Species — P. albiflora. *Originated by* Pleas (?)
Donated by Pleas.

Description of bloom — Type of bloom rose. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) violet rose 2 (154); guards flecked with green; collar same color as guards; center occasionally flecked crimson; uniform color throughout. Very attractive, well formed, delicate bloom. Center fades to lilac white. Fragrance pleasant X. Blooming time mid-season. Size large to very large.

Description of plant — Habit of plant medium erect, medium height, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium to light green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

LOVELINESS.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Color (total effect) 1 (132) hydrangea pink fading to lilac white; guards clear; uniform color throughout; secondary staminodes present. Fragrance pleasant X. Blooming time mid-season. Size medium.

Description of plant — Habit of plant erect, medium tall, medium compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, dark green, coarse; veins red.

Commercial value — For cut bloom medium; landscape value good. Variety as a whole good.

LUCIE MALARD.

Species — P. albiflora. *Originated by* Crousse, 1879.

Donated by Dessert.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) 3 (154) violet rose; guards flecked with green; collar same as guards; center clear; secondary staminodes present. Fragrance pleasant XX. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect, tall, medium compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, light green, coarse; veins green.

Commercial value—For cut bloom good; landscape value good. Variety as a whole good.

MADAME MUYSSART.

Species — P. albiflora. *Originated by* Calot, 1869.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom rose. Form of bloom flat, very compact. Not differentiated. Entirely transformed. Color (total effect) 1 (157) solferino red; guards streaked light; center clear; uniform color throughout; secondary staminodes present. Bloom is silver tipped. Fragrance pleasant X. Blooming time late. Very large size.

Description of plant — Habit of plant erect, medium tall to tall, compact. Growth strong and healthy. Stem long, strong, green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

MARCHIONESS OF LANSDOWNE.

Species—P. albiflora. *Originated by* Kelway.
Donated by Farr.
Description of bloom—Type of bloom rose. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) 1 (132) hydrangea pink; guards clear; collar same as guards; center flecked slightly with crimson; secondary staminodes present. Full, double, imbricated flower, shaded somewhat darker in the center. Fragrance pleasant X. Blooming time midseason. Large size.
Description of plant—Habit of plant medium erect, medium height, medium compact. Growth strong and healthy. Stem medium long, medium strong, red. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins reddish green.
Commercial value—For cut bloom good; landscape value good. Variety as a whole good.

MARMONTEL.

Species—P. albiflora. *Originated by* Crousse, 1898.
Donated by Minot.
Description of bloom—Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) 1 (154) violet rose; guards clear; center clear. Bloom is silvery tipped. Fragrance pleasant X. Blooming time late. Medium to large size.
Description of plant—Habit of plant erect, medium height, compact. Growth strong. Cornell specimens diseased. Stem medium long to long, medium strong, reddish green. Blooming habit medium. Buds borne in clusters, slight blight. Foliage medium furnished, dark green, fine; veins reddish green.
Commercial value—For cut bloom medium; landscape value medium. Variety as a whole medium.

MAUD L. RICHARDSON.

Species—P. albiflora. *Originated by* Hollis.
Donated by Hollis.
Description of bloom—Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) pale lilac rose 2 (178); guards clear; center clear, fades lighter than guards; secondary staminodes present. Remnants of anthers concealed on petals around collar Fades to hydrangea pink. Fragrance pleasant XX. Blooming time late. Medium to large size.
Description of plant—Habit of plant drooping, tall, medium compact. Growth strong, healthy. Stem long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium to light green, medium size; veins reddish green.
Commercial value—For cut bloom good; landscape value medium to poor. Variety as a whole medium.

MILTON HILL.

Species—P. albiflora. *Originated by* Richardson.
Donated by Shaylor.
Description of bloom—Type of bloom rose. Form of bloom globular, compact.

Not differentiated. Entirely transformed. Color (total effect) 1 (130) pale lilac rose; guards clear; collar same as guards; center clear. Very distinct, pure color. Fragrance lacking. Blooming time late. Very large size.

Description of plant — Habit of plant drooping, medium height, medium compact. Growth strong. Stem medium long, medium strength, green. Blooming habit medium. Buds borne in clusters. Foliage medium furnished, light green, medium size; veins green.

Commercial value — For cut bloom good; landscape value medium. Variety as a whole good.

Synonym — "Augustus Gould."

MONSIEUR BARRAL.

Species — P. albiflora. *Originated by* Calot, 1866.

Donated by Jackson & Perkins, and Farr.

Description of bloom — Type of bloom rose. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) pale lilac rose 1 (130); guards clear; collar same as guards; center clear. Same color as "Livingstone"; fades silver tipped. Fragrance pleasant XXX. Blooming time late. Very large size.

Description of plant — Habit of plant somewhat drooping, tall, open. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage poorly furnished, light green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

MONSIEUR HIPPOLYTE DELILLE.

Species — P. albiflora. *Originated by* Calot, 1872.

Donated by Croux et Fils.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) pale lilac rose 1 (178), fading in center nearly white; guards clear; collar same as guards; center clear; uniform color; only a few secondary staminodes present. A very attractive bloom. Fragrance pleasant XX. Blooming time late. Large size.

Description of plant—Habit of plant medium erect, medium dwarf, compact. Growth strong and healthy. Stem medium long, medium strong, green. Blooming habit medium. Lateral buds undeveloped, slight blight. Foliage well furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

ROSA BONHEUR.

Species — P. albiflora. *Originated by* Dessert.

Donated by McKissock.

Description of bloom — Type of bloom rose with wide, imbricated petals. Form of bloom flat. Color (total effect) violet rose 1 (154); guards prominently flecked with crimson; collar same color as guards; center clear; secondary staminodes absent. Fragrance pleasant. Blooming time mid-season. Very large size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium length, strong, reddish green. Blooming habit free Buds borne in clusters. Foliage well furnished, medium green, medium size; veins red.

Commercial value — For cut bloom good; landscape value extra good. Variety as a whole good to extra good.

SPEEDWELL.

Species — P. albiflora. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom—Type of bloom rose. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) 1 (157) solferino red; guards clear; uniform color throughout; secondary staminodes present. Cream white, narrow petals concealed throughout the bloom. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant medium erect, medium tall to tall, compact. Growth medium strong, healthy. Stem medium long, medium strong, reddish green. Blooming habit medium. Buds borne in clusters, blight. Foliage medium furnished, dark green, fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

Remarks—Very similar to "Docteur Bretonneau" (Verdier), but rather inferior to it.

SULLY PRUDHOMME.

Species—P. albiflora. *Originated by* Crousse, 1898.

Donated by Farr, and De Graaf Brothers.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact to loose. Not differentiated. Entirely transformed. Color (total effect) 1 (132) hydrangea pink; guards clear; collar same as guards; center clear Bloom fades from hydrangea pink to milk white. Fragrance pleasant X. Blooming time mid-season. Large size.

Description of plant — Habit of plant medium erect, medium tall, medium compact. Growth medium strong, healthy. Stem medium long, medium strong, reddish green. Blooming habit medium. Buds single, healthy. Foliage medium furnished, light green, medium size; veins reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

SUPREME.

Species — P. albiflora.. *Originated by* Hollis, 1907.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom globular, medium compact. Not differentiated. Entirely transformed. Color (total effect) 3 (154) violet rose; guards slightly flecked; collar same as guards; center clear; uniform color throughout; secondary staminodes present. Fragrance unpleasant X. Blooming time very late. Large size.

Description of plant — Habit of plant medium erect, medium tall, compact. Growth strong and healthy Stem medium long, very strong, green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, medium green, medium size; veins green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

SWEET HOME.

Species — P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Descripion of bloom — Type of bloom rose. Form of bloom flat, loose. Not differentiated. Entirely transformed. Color (total effect) 1 (154) violet rose; guards clear; collar same as guards; center clear; uniform color throughout; secondary staminodes present. Bloom fades quickly. Fragrance pleasant X. Blooming time late. Size medium to large.

Description of plant — Habit of plant medium erect to drooping, tall, medium compact. Growth strong and healthy. Stem long, medium strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage medium furnished, light green, medium size; veins green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

THÉRÈSE.

Species — P. albiflora. *Originated by* Dessert, 1904.

Donated by Cottage Gardens Company.

Description of bloom — Type of bloom rose. Form of bloom flat, medium compact. Not differentiated. Entirely transformed. Color (total effect) violet rose 2 (154); guards slightly splashed with crimson; collar same as guards; center clear, fading lilac white. Fragrance pleasant XX. Blooming time mid-season. Very large size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins red.

Commercial value — For cut bloom good; landscape value good. Variety as a whole extra good.

Remarks—One of the most beautiful varieties in color and form.—*A. P. S.* and *B. H. F.*

ANDRÊ LAURIES.

Red

Species — P. albiflora. *Originated by* Crousse, 1881.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom globular, very compact. Not differentiated. Transformed. Color (total effect) dark tyrian rose 3 (155); guards occasionally splashed with green; collar same as guards; center splashed with white; secondary staminodes absent. Very dense compact bloom, shading deeper in center, with red reflex. Fragrance absent. Blooming time very late. Very large size.

Description of plant — Erect, medium tall, compact. Growth strong, healthy. Stem medium to long, very strong, reddish green. Blooming habit very free. Buds borne in clusters, healthy. Foliage well furnished, dark green, medium size; veins green.

Commercial value — For cut bloom extra good; landscape value good. Variety as a whole extra good.

Remarks — Entirely distinct from the variety commonly sold under this name, which should be known as "Fragrans," see page 63.

EDWIN BOOTH.

Species — P. albiflora. *Originated by* Hollis, 1905.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom globular, medium compact. Not entirely differentiated. Entirely transformed. Color 4 (155) tyrian rose; guards clear; center clear, uniform color; secondary staminodes present. Fragrance pleasant X. Blooming time late. Small size.

Description of plant—Habit of plant medium erect; medium tall, compact. Growth strong, diseased. Stem medium long, medium strong, red. Blooming habit medium to shy. Buds borne in clusters, blight. Foliage medium furnished, dark green, fine; veins reddish green.

Commercial value — For cut bloom poor; landscape value poor. Variety as a whole poor.

GOLIATH.

Species — P. albiflora. *Originated by* Hollis, 1907-1909.

Donated by Farr.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) 1 (155) tyrian rose; guards clear; collar same as guards; center clear. Bloom has slight silver tip. Fragrance pleasant XX. Blooming time mid-season. Size very large.

Description of plant — Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage well furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

LIBERTY.

Species — P. albiflora. *Originated by* Hollis, 1905.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Not differentiated. Entirely transformed. Color (total effect) 4 (182) magenta; guards flecked with green; center clear; uniform color; secondary staminodes present. Bloom fades silvery. Fragrance pleasant X. Blooming time mid-season. Medium size to small.

Description of plant — Habit of plant medium erect to drooping, medium height. medium compact. Growth strong and healthy. Stem long, medium strong to weak, reddish green. Blooming habit medium. Buds borne in clusters, slight blight. Foliage medium furnished, medium green, medium size; veins reddish green.

Commercial value — For cut bloom medium; landscape value medium. Variety as a whole medium.

LINNÉ.

Species — P. albiflora. *Originated by* Verdier, 1860.

Donated by Perennial Gardens.

Description of bloom — Type of bloom rose. Form of bloom globular, compact. Slightly differentiated. Entirely transformed. Color (total effect) tyrian rose 1 (155); guards slightly flecked; collar same color as guards; center flecked with crimson; secondary staminodes present. Compact, imbricated bloom. Similar to "Madame Lebon." Linear cream petals concealed throughout the bloom. Fragrance pleasant X. Blooming time mid-season. Medium size.

Description of plant — Habit of plant erect, medium tall, compact. Growth strong and healthy. Stem medium long, strong, reddish green. Blooming habit free. Buds borne in clusters, healthy. Foliage medium furnished, dark green, medium size; veins reddish green.

Commercial value — For cut bloom good; landscape value good. Variety as a whole good.

RED CROSS.

Species — P. albiflora. *Originated by* Hollis, 1904.

Donated by Hollis.

Description of bloom — Type of bloom rose. Form of bloom flat, compact. Slightly differentiated. Entirely transformed. Color (total effect) 4 (155) tyrian rose; guards clear; center clear; uniform color throughout; secondary staminodes present. Fragrance pleasant X. Blooming time late. Medium to small size.

Description of plant—Habit of plant erect, tall, compact. Growth strong and healthy. Stem long, medium strong to weak, reddish green. Blooming habit medium to free. Buds borne in clusters, healthy. Foliage poorly furnished, dark green, fine; veins green.

Commercial value — For cut bloom poor; landscape value medium. Variety as a whole medium.

TWENTIETH CENTURY.

Species — P. albiflora. *Originated by* Hollis.

Donated by Hollis.

Description of bloom—Type of bloom rose. Form of bloom flat, compact. Not differentiated. Entirely transformed. Color (total effect) 2 (155) tyrian rose; guards streaked light; collar same as guards; center clear; uniform color throughout; secondary staminodes present. Fragrance unpleasant XX. Blooming time mid-season to late. Large size.

Description of plant — Habit of plant medium erect, very tall, medium compact. Growth strong and healthy. Stem very long, medium strong, reddish green. Blooming habit medium. Buds borne in clusters, healthy. Foliage poorly furnished, dark green, medium size; veins red.

Commercial value — For cut bloom medium; landscape value poor. Variety as a whole medium.

INDEX TO VARIETY DESCRIPTIONS

	BULL.	PAGE
Abel de Pujol	278	268
Acanum	278	255
Achille	278	279
Active	306	62
Adam Bede	278	238
Adelaide E. Hollis	306	87
Adele	306	62
Admiral Dewey	306	107
Admiral Togo	306	126
Adolphe Rousseau	306	84
Agnes Mary Kelway	278	253
Aksarben	306	126
Alba Formosa	278	248
Alba Maxima	306	62
Alba Plena	278	261
Alba Sulfurea	306	102
Albâtre	278	279
Albert Crousse	306	102
Alexandre Dumas	278	252
Alexandriana	259	139
Alfred de Musset	278	281
Alice Crousse	278	264
Alice de Julvécourt	306	103
Alsace Lorraine	306	114
Amalathea	278	261
Amazone	278	280
Ambroise Verschaffelt	278	295
American Beauty	306	62
André Lauries	278	271
	306	152
Anemoneflora Alba	278	240
Anemoneflora Rubra	278	241
Anna	306	62
Antietam	306	84
Antoine Poiteau	306	88
Armand Rousseau	259	135
	278	243
Armandine Mechin	259	134
	278	236
Arsène Meuret	306	119
Arthemise	278	255
Asa Gray	259	135
Aspasie	259	131
Atrosanguinea	278	244
Attraction	306	75
Auguste Gauthier	306	127
Auguste Lemonier	306	79
Auguste Villaume	306	142
Augustin d'Hour	278	270
Aurora (Pleas)	278	237
Aurora (Hollis)	306	78
Aurore	306	114
Austin Chamberlain	306	71
Autumnus	306	71
Avalanche	259	137
	278	230
Baron James de Rothschild	278	259
Baroness Schroeder	306	132
Battlefield	306	119
Beauté Française	278	251
Beauté de Villecante	278	251
Beauty's Mask	306	96
Bélisaire	306	119
Belle Châtelaine	278	263
Belle Douaisienne	306	142
Belle of France	306	142
Belle Mauve	306	143

	BULL.	PAGE
Belle of York	278	242
Beranger	306	143
Berlioz	259	141
	278	230
Bernard de Palissy	278	290
Bicolor	278	251
Bismark	306	127
Blanche Cire	306	88
Blanche Dessert	306	120
Boule de Neige	306	114
Brennus	306	63
Bridesmaid	278	242
Bunch of Perfume	278	291
Buyckii	306	106
Cameron	278	293
Camille Calot	259	141
Canari	259	131
	278	231
Canariensis	306	103
Candidissima	259	138
Canista	278	266
Carlotta Grisi	278	253
Carmen	306	120
Carnea Elegans (Calot)	278	262
Carnea Elegans (Guerin)	306	143
Carnea Humei	278	287
Carnea Striata	306	133
Carnea Triumphans	278	252
Cavalleria Rusticana	306	127
Ceres	306	107
Cerisette	306	120
Charlemagne	278	280
Charles Binder	278	269
Charles de Belleyme	306	84
Charles Gosselin	278	241
Charles Toché	306	121
Charles Verdier	259	141
Charlotte Cushman	306	144
Cherita	278	274
Chinensis Rubra	306	63
Christine Ritcher	306	144
Christopher Archard	306	96
Chrysanthemiflora	259	130
	278	232
Cinderella	306	74
Claire Dubois	306	144
Clara Barton	306	115
Clara Hersey	306	144
Clarissa	278	266
Claude Gelée	306	133
Clementine Gillot	306	100
Clio	259	128
	278	238
Comte de Cayes	306	63
Comte de Cussy	278	255
Comte de Diesbach	278	269
Comte de Jussieu	306	96
Comte de Nanteuil	306	107
Comte d'Osmont	259	138
Comte de Paris	278	252
Comtesse O'Gorman	278	264
Conquerer	306	145
Constant Devred	259	141
Continental	306	85
Coquelin	306	127
Countess of Warwick	306	69
Coupe d'Hebe	306	97

	BULL.	PAGE
Couronne d'Or	259	133
Crimson Queen	278	294
Crown of Thorns	306	75
Curiosity	306	79
Cyclops	278	277
Cyntherii	278	247
Cythérée	306	97
Daniel d'Albert	306	112
Daubenton	278	266
Daybreak	306	81
Decaisne	278	269
De Candolle	259	141
De Jussieu	278	238
Delachei	259	135
	278	233
Delecourt Verhille	306	103
Delia	278	256
Delicatissima	278	284
Denis Helye	278	277
Departing Sun	306	108
Descartes	306	85
Diamond	306	63
Dorchester	278	284
Dorothy	306	69
Dorothy E. Kibby	306	133
Dr. Bretonneau (Guerin)	278	280
Dr. Bretonneau (Verdier)	278	263
Dr. Caillot	278	274
Dr. Edgar Pleas	278	238
Duc de Cazes	278	256
Duc de Wellington	259	131
Duchesse de Nemours	278	249
Duchesse d'Orleans	278	267
Duguesclin	306	121
Duke of Clarence	306	63
Duke of Devonshire	306	145
Early Rose	278	256
Eastern Beauty	306	94
Edmond About	306	145
Edmond Lebon	278	288
Edouard André	278	243
Edulis	306	63
Edulis Alba	306	104
Edulis Fragrans	306	63
Edulis Odorata	278	256
Edulis Superba	278	257
Edwin Booth	306	153
Edwin Forrest	306	112
E. G. Hill	306	128
Elegans Superbissima	306	104
Elie Chevalier	306	101
Ella Christine Kelway	278	288
Emile Lemoine	278	267
Emily	306	70
Emma	278	257
Emmchen	306	133
Empereur Nicolas	278	278
Emperor William	306	63
Enchantment	306	121
Enchantresse	306	134
Enfant de Nancy	259	139
	278	290
Etendard du Grand Homme	278	294
Etienne Denis	278	256
Etienne Mechin	278	260
Etta	306	146
Eugene Bigot	278	276
Eugène Reignoux	306	85
Eugène Verdier	278	293
Eugénie Verdier	306	122
Euphemia	259	135
Eureka	306	79
Evening Glow	306	81
Exquisite	278	237
Fairy Queen	306	63
Faust	278	247
Favorite	306	108
Félix Crousse	259	142
	278	232
Festiva	259	138
Festiva Maxima	259	138
Flag of Truce	306	69
Flag of War	306	71

	BULL.	PAGE
Flambeau	278	275
Flashlight	306	76
Floral Treasure	278	284
Formosa	278	262
Formosa Alba	259	138
	278	248
Formosa Rosea	278	257
Fragrans	306	63
Fragrantissima	306	64
François 1st	259	132
	278	260
François Ortegat	259	135
Frank Bramley	306	72
Frina	306	64
Fulgida	278	245
Galene	306	64
General Bedeau	306	108
Général Bertrand	259	142
	278	231
Général Cavaignac	306	122
General Custer	306	81
Général Dodds	306	128
General Hooker	306	128
General Lawton	259	136
George Hollis	306	141
George Washington	306	129
Georgiana Shaylor	306	122
Germaine Bigot	306	97
Gettysburg	306	101
Gigantea	306	64
Globosa	278	286
Gloire de Charles Gombault	278	252
Gloire de Chenonceaux	278	286
Gloire de Deumai	278	258
Glory	306	76
Glory of Somerset	306	108
Gold Nugget	306	79
Golden Harvest	278	264
Golden Wedding	306	77
Goliath	306	153
Goodspeed	306	146
Grandiflora (Richardson)	306	134
Grandiflora Alba Laciniata	278	248
Grandiflora Carnea Plena	278	248
Grandiflora Nivea Plena	278	248
Grandiflora Rosea	259	139
Grandiflora Rubra	278	294
Graziella	306	88
Gretchen	278	253
Grizzel Muir	306	104
Grover Cleveland	278	293
Gypsy	306	76
Habid	306	64
Happy Day	306	141
Harriet Beecher Stowe	306	82
Hector	278	258
Henri Laurent	259	142
Henri Murger	306	146
Henry Demay	278	269
Henry Woodward	259	142
Hercules	306	109
Hericartiana	278	264
Hity Tity	306	74
Humei	278	287
Humei Alba	306	134
Innocence	306	74
Insignis	278	270
Intermedia	259	129
	278	239
Irma	306	147
Isabella Karlitzky (synonym)	306	64
Isabelle Karlitsky	259	142
James Blanc	306	123
James Kelway	306	115
Jeanne d'Arc	259	131
	278	230
Jenny Lind	278	267
Jessie K. Crosby	306	147
John Hancook	306	86
Josephine	278	238
Jules Calot	259	143
	278	283
Juliette Dessert	278	294

	BULL.	PAGE
Jupiter (Kelway)	306	72
Jupiter (Calot)	259	136
Jussier	278	245
Karl Rosenfield	306	129
Kelway's Queen	306	147
King Philip	278	271
Labolas	278	240
L'Avenir	306	80
La Brune	278	276
La Coquette	259	143
	278	232
L'Eclatante	278	270
L'Espérance	278	247
La Fée	306	98
La Fiancée (Dessert)	259	128
	278	234
La Fiancée (Lemoine)	278	247
La Fontaine	306	109
La France	306	137
La Perle	278	281
La Rosière	259	133
La Sublime	306	86
La Tendresse	306	137
La Tulipe	259	133
La Vestale	306	91
Lady Beresford	278	273
Lady Brooke	278	240
Lady Darmouth	306	134
Lady Leonora	306	64
Lady Leonora Bramwell	278	265
Lafayette	278	294
Lamartine	278	288
Le Cygne	306	115
Lee's Grandiflora	306	64
Lemoine	278	289
Leucadia	306	70
Liberty	306	153
Lilacina Superba	278	258
Linné	306	153
Livingston	278	289
Lord Roberts	306	64
Lost Treasure	306	147
Lottie Collins	278	276
Louis Van Houtte	259	136
Louise d'Estrees	278	266
Louise Renault	278	291
Loveliness	306	148
Lucie Malard	306	148
Lucrece	278	253
Lucy E. Hollis	306	137
Lurana	278	275
Lutea Plenissima	278	249
Lutetiana	306	94
Madame Adrien Sénéclauze	306	129
Madame Auguste Dessert	306	130
Madame Barillet Deschamps	259	136
	306	123
Madame Becquet	278	244
Madame Benard	278	282
Madame Bigot	306	101
Madame Bollet	278	282
Madame Bréon	278	261
Madame Calot	259	139
	278	231
Madame Camille Bancel	278	282
Madame Carpentier	306	82
Madame Chammie	278	266
Madame Chaumy	278	283
Madame Costé	306	109
Madame Courant	306	80
Madame Crousse	278	247
Madame de Bollemont	278	243
Madame de Galhau	278	285
Madame de Govin	278	285
Madame de Guerle	278	241
Madame d'Hour	278	287
Madame de Montijo	278	249
Madame de Tréyéran	306	116
Madame de Vatry	278	251
Madame de Vernéville	278	263
Madame Ducel	259	132

	BULL.	PAGE
Madame Émile Gallé	259	139
	306	138
Madame Émile Lemoine	278	273
Madame Forel	278	285
Madame Fould	306	138
Madame Furtado	278	267
Madame Geissler	259	143
	278	234
Madame Guyot	306	91
Madame Herve	278	286
Madame Hutin	278	275
Madame Joanna Sallier	306	82
Madame Jules Calot	278	272
Madame Jules Elie	306	98
Madame Lebon	278	288
Madame Lemoine	306	94
Madame Lemoinier	278	281
Madame Mechin	278	278
Madame Modeste	306	65
Madame Moreau	259	143
Madame Moutot	306	130
Madame Muyssart	306	148
Madame Raguet	278	291
Madame Savreau	306	91
Madame Schmidt	278	259
Madame Vilmorin	306	138
Mademoiselle Desbuissons	306	116
Mademoiselle Léonie Calot	278	280
Mademoiselle Marie Calot	306	139
Mademoiselle Renée Dessert	259	143
Mademoiselle Rose Rendatler	306	95
Mademoiselle Rousseau	259	134
	278	273
Mademoiselle Vaillant	306	104
Maiden's Blush	278	254
Mamie Cutler	278	256
Marcelle Dessert	306	91
Marchioness of Lansdowne	306	149
Maréchal MacMahon	278	271
Maréchal Vaillant	278	293
Marguerite Gérard	259	134
	278	235
Marie	306	116
Marie Crousse	306	110
Marie Deroux	306	139
Marie d'Hour	278	287
Marie Houillon	278	287
Marie Jacquin	259	134
	278	235
Marie Lemoine	278	281
Marie Louise	278	289
Marie Stuart (Calot)	278	255
Marie Stuart (synonym)	306	65
Marmontel	306	149
Marquis d'Lory	306	65
Marquis Ito	306	65
Mary A. Livermore	306	139
Mary L. Hollis	306	123
Masterpiece	259	136
Mathilde De Roseneck	259	144
Mathilde Mechin	259	140
	278	267
Maud L. Richardson	306	149
May Davidson	306	70
Meadowvale	306	110
Meissonier	278	271
Melanie Henry	278	286
Merveilleuse	306	65
Microcarpa	259	129
Mikado	259	130
Miles Standish	306	86
Millais	306	72
Milton Hill	306	149
Miss Brice	306	65
Miss Salway	306	92
Modèle de Perfection	278	289
Modesty	306	73
Modeste Guérin	259	144
	278	235
Monsieur Andre	278	251
Monsieur Barral	306	150

	BULL.	PAGE
Monsieur Bastien Le Page	278	258
Monsieur Boucharlat aîné	278	273
Monsieur Charles Leveque	306	65
Monsieur Chevreul	259	140
	278	284
Monsieur de Villeneuve	278	261
Monsieur Doffrey	306	65
Monsieur Dupont	259	134
	278	233
Monsieur Hippolyte Delille	306	150
Monsieur Jules Elie	306	110
Monsieur Krelage	278	277
Monsieur Marsaux	259	129
	278	239
Monsieur Martin Cahuzac	278	276
Monsieur Paillet	278	258
Monsieur Paul du Ribert	278	272
Monsieur Rousselon	278	255
Mont Blanc	306	140
Morning Star	306	78
Mountebank	278	240
Mr. Manning	278	278
Mrs. Gwyn-Lewis	259	130
Mrs. John Smythe Fogg	306	95
Mrs. Lowe	278	262
Mrs. Sagute	306	65
Myrtle	306	98
Ne Plus Ultra	306	82
Nell Gwynn	306	65
Neptune	306	92
Nico	306	86
Nigricans	306	130
Nivalis	278	254
Nivea Plenissima	259	140
	306	105
Nobilissima	306	123
Noemie Demay	259	144
	278	233
Nominata	278	290
Octave Demay	259	137
Pallas	278	243
Pallasi	259	129
Papaveriflora	278	249
Papilionacea	306	66
Paradise	306	140
Paradoxa	259	130
Paul Verdier	278	260
Pearl	306	66
Peregrina	259	129
Perfection (Richardson)	259	140
Perfection (synonym)	306	66
Peter Pan	306	124
Petite Renée	278	242
Philomèle	278	254
Phoenica Variegata	306	66
Phrynnée	306	66
Pierre Dessert	278	277
Pierre Reignoux	306	130
Pizano	278	258
Plena Variegata	306	66
Plenissima Rosea Superba	259	140
	278	268
Plutarch	278	245
Pompon Chamois	306	111
Portia	278	250
Pottsi	278	278
Prairie Splendor	306	124
President de Montzey	259	144
President Wilder	306	92
Prince Alert	306	77
Prince d'Salm Dyck	278	265
Prince Imperial	278	278
Princess Beatrice	278	250
Princess Ellen	278	250
Princess Galitzin	278	265
Princess Maud	278	263
Princess May	306	66
Princesse Nicolas Bibesco	306	95
Princess of Wales	306	99
Prolifera	306	66
Prolifera Tricolor	278	254
Pulcherrima	278	268
Purpurea Superba	306	102
Queen Emma	306	141
Queen Esther	306	66
Queen of the Pinks	278	275
Queen's Perfection	278	250
Queen Victoria (Kelway)	306	93
Queen Victoria (synonym)	306	66
Raphael	306	131
Rare Brocade	306	105
Red Cross	306	154
Red Jacket	278	295
Reevesiana	306	67
Reine des Roses	278	265
Reine Hortense	306	124
Reine Victoria	306	105
René Potard	259	131
	278	268
Rosa Barry	306	67
Rosa Bonheur	306	150
Rosa Lilacina	278	259
Rosamond	306	67
Rose Quintal	278	291
Rosea	278	272
Rosea Elegans	306	111
Rosea Magna	306	80
Rosea Plenissima	306	67
Rosea Plenissima Superba	306	67
Rosea Superba	306	67
Rosetta	306	67
Rosilita	306	111
Rossini	306	131
Rosy Gem	259	130
	278	239
Rubens	278	239
Rubicunda	306	111
Rubra	259	133
Rubra Superba	278	295
Rubra Triumphans	306	87
Ruy Blas	306	125
Sabina	306	106
Sailet	278	241
Sainfoin	278	259
Samoset	306	131
Sapho	278	275
Sarah Bernhardt (Dessert)	278	282
Sarah Bernhardt (Lemoine)	306	125
Sea Foam	306	93
Senator	306	132
Sidonie	278	292
Simonne Chevalier	306	99
Snowball	306	140
Snow White	306	67
Solfatare	278	250
South Weymouth	306	83
Souvenir du Docteur Bretonneau	306	87
Souvenir de Gaspard Calot	278	283
Souvenir de l'Exposition de Bordeaux	306	113
Souvenir de l'Exposition du Mans	278	245
Souvenir de l'Exposition Universelle	259	144
	278	234
Speedwell	306	151
Splendida	259	139
Standard Bearer	306	112
Stanley (Crousse)	278	292
Stanley (Kelway)	306	73
Stewart's America	259	140
	306	67
Sulfurea	306	93
Sully Prudhomme	306	151
Sunbeam	306	75
Sunrise	306	75
Superba	278	260
Supreme	306	151
Sweet Home	306	152
Sylvanus	278	260
Taglioni	306	99
Teniers	259	132
	306	132
The Bride	278	262
The King	306	73
The Moor	259	129
	278	239
The Queen	306	69
Theodore Roosevelt	306	83

	BULL.	PAGE
Thérèse	306	152
Thisbé	306	68
Thorbeckii	278	292
Thurlow's Double Red	278	244
	306	68
Tragedy	306	113
Triomphe de l'Exposition de Lille	278	274
Triomphe du Nord	259	132
Triumphans Gandavensis	259	141
	306	68
Triumphata	306	94
Trojan	306	125
Twentieth Century	306	154
Umbellata Rosea	278	292
Usona	306	116
Van Dyck	306	99
Venus	306	100
Veribest	306	140
Vesta	306	71
Vicomtesse de Belleval	306	100
Victoire de l'Alma	278	279
Victoire Lemon	278	253
Victoire Modeste	259	132
Victor Durufle	306	68
Victor Hugo	259	133
Victor Lemoine	259	137
Victor Paquet	278	290
Ville de Nancy	259	144
	278	271
Ville de Poissy	259	137
Virginie	259	137
Virgo Maria	259	131
Volcan	259	145
	278	236
Walter Faxon	306	126
Washington	306	113
Water Lily	278	242
Welcome Guest	306	83
White Lady	306	73
Whitleyi	306	106
Witch	306	77
Youth	306	78

NOVEMBER, 1911 BULLETIN 307

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Horticulture

AN APPLE ORCHARD SURVEY OF ONTARIO COUNTY

Under the direction of
JOHN CRAIG
Professor of Horticulture

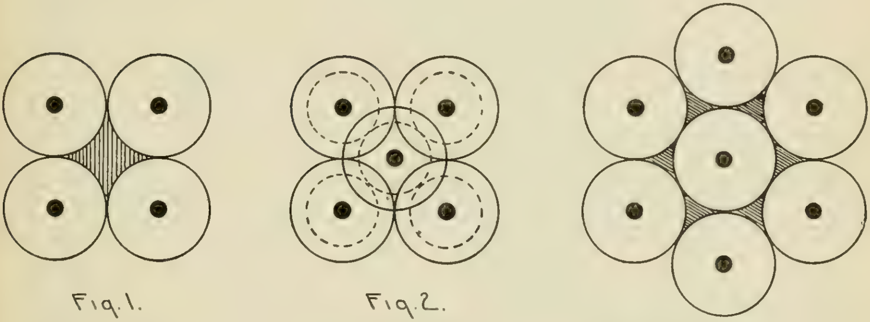


Fig. 1. SQUARE
Fig. 2. QUINCUNX
Fig. 3—HEXAGONAL

Square, quincunx, and hexagonal planting plans for orchards

BY H. M. MARTIN

ITHACA, N. Y.
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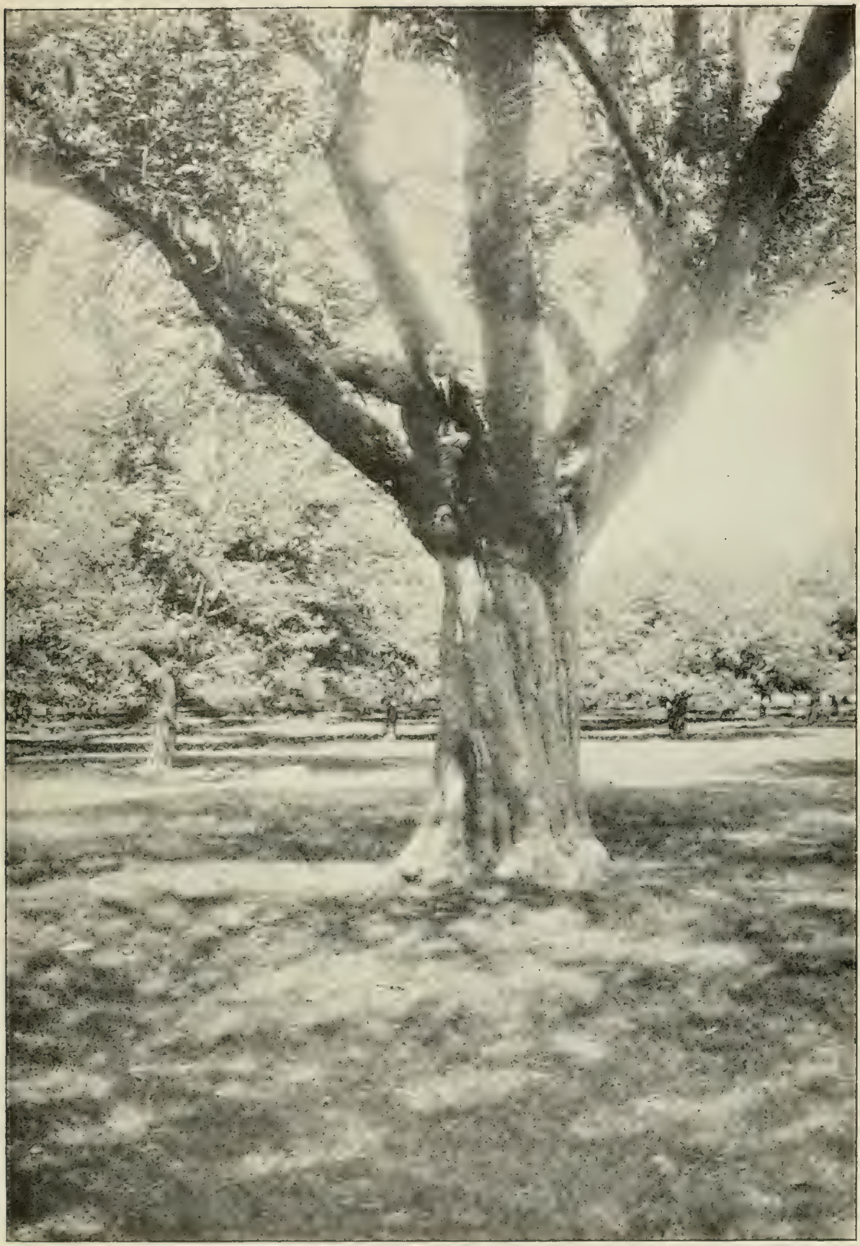

FIG. 17.—*One of the oldest Hubbardston apple trees in Ontario county. Orchard of T. B. Wilson, Halls Corners*

PREFACE

This bulletin, presenting a graphic picture of conditions and results attending apple growing in Ontario county, is the fourth of the series devoted to the findings of surveys of important apple-producing counties in New York State. Studies of prevailing practices as affecting the apple industry have been made in Wayne, Orleans, Niagara, Ontario, Monroe, and Orange counties. The results of the apple survey of the first four counties will, with the publication of this bulletin, have been presented to the growers who have contributed the data, in the hope that these leaves from the book of their own experience, when carefully studied, will prove highly helpful. Indeed they can hardly be otherwise.

The field work, as stated by the author, was done by Messrs. A. W. McKay and W. A. Salisbury under the supervision of Professor C. S. Wilson. The heavy and difficult task of collating and tabulating the data and drawing conclusions from the figures obtained was faithfully executed by Miss Harriett M. Martin, the author of the bulletin, who also visited a number of the orchards of the county with survey blanks in hand in order to secure information and point of view which would assist her in properly interpreting the results. These tables have been carefully scrutinized by the present writer, who is thoroughly assured of the accuracy of the tabulation methods employed.

In the main, the results of this study of apple-growing conditions in Ontario county corroborate the findings of the earlier surveys. This bulletin shows that apple growing in this county is a highly profitable industry. It proves that profits are secured largely in proportion to the application of intelligent, up-to-date methods. It demonstrates that spraying is a highly profitable practice, and that fertilizing and cultivating are indispensable to the fullest returns. These are fundamentals; yet they are often overlooked. The figures show that it pays to cultivate. Our former bulletins of the series emphasized the same thing. All orchards in Ontario county will not be cultivated as a consequence of the facts set forth in this bulletin, but certain it is that tillage of some kind or type a part or all of the time pays better than continual sod methods. The man who cultivates is making the most money, and the commercial apple grower is looking for dollars more than for the gratification of sentiment.

This bulletin should stimulate a keener interest in orchard management, for the facts it contains indicate that the orchardists of Ontario county are admirably situated to meet successful competition in the production of staple winter apples.

The appendix contains a brief discussion of some of the principles underlying statistical methods. This is inserted not for the purpose of attempting to establish a system, but rather to point out the important features to be considered in connection with studies of this kind.

JOHN CRAIG.

AUTHOR'S ACKNOWLEDGMENTS

Acknowledgment is here made to the many farmers throughout Ontario county who so courteously contributed the information on which the study is based. Thanks and appreciation are most cordially extended to Professors Craig and Wilson of the departments of Horticulture and Pomology, Professors Snyder and McMahon of the Department of Mathematics, Doctor Love, Professor H. W. Riley, and others, for the many helpful suggestions they have given in regard to the work. All photographs were obtained through the courtesy of the Department of Horticulture.

H. M. Martin

CONTENTS

PAGE

Value of the apple crop ... 170
Purpose of the 1908 survey ... 170
Collection of data ... 170
Methods of tabulation ... 170
The geographical distribution of orchards ... 172
General average yield and income for the county ... 172
Distribution of orchards according to yield and income ... 174
Size of orchards ... 177
  Distribution of orchards according to size ... 177
  Relation of size of orchard to yield and income ... 178
Condition of orchards ... 179
  Relation of condition of orchard to yield and income ... 179
Aspect of orchards ... 180
  Relation of aspect to yield and income ... 181
Elevation ... 181
  Distribution of orchards according to elevation ... 181
  Relation of elevation of orchards to yield and income ... 182
Age of trees ... 183
  Relation of age of trees to yield and income ... 183
Varieties ... 184
Planting plan ... 184
  Relation of distance of trees to yield and income ... 187
Pruning ... 188
Soil types ... 189
  Relation of soil type to yield and income ... 189
Drainage ... 189
  Relation of drainage to yield and income ... 190
Soil management ... 192
  General practice ... 192
  Relation of soil management to yield and income ... 192
  Management of sod orchards ... 194
  Relation of pasturage to yield and income ... 195

PAGE
Fertilizers 196
  General practice 196
  Relation of fertilizers to yield and income 197
  Stable manure 198
    Correlation of quantity and frequency of application 198
    Relation of quantity and frequency of application to yield and income 198
Orchard pests and diseases 199
Spraying 200
  General practice 200
  Relation of spraying to yield and income 202
Summary of the survey 203
Appendix — Part I 206
  Tables for 1907 and 1908 .... 206, 207
Appendix — Part II. Statistical methods as applied to orchard surveys 208
  General theoretical considerations 208
  The principles underlying statistics 208
    Law of probability and normal distribution 208
    Averages 209
    Measure of variability 209
    Comparison by percentages 210
  The orchard survey from the statistical standpoint 210
  Bibliography 214

AN APPLE ORCHARD SURVEY OF ONTARIO COUNTY

H. M. Martin

Apple growing in Ontario county dates back to the time of the Indians. Some of the old trees still remain, but most of the orchards were cut down by General Sullivan during his raid in 1779.

" Tradition states that four miles west of Geneva, on the farm of Nathan White, a small nursery of sprouts was established in 1792 among the stumps of an old Indian orchard. On this site and from these sprouts an orchard grew. Mr. C. C. Whitney owned the farm 1843–1884, and at the latter date the orchard was still profitable.

* * * * * * * *

" Near Seneca Castle, near Geneva, the Indians had planted a small orchard which General Sullivan did not destroy. * * * It was called the Indian Castle orchard. Most of the orchards of the early settlers in this section were grown from seeds taken from this old Indian orchard.

* * * * * * * *

"An orchard standing near where the New York State Experimental Station is located is said to have been set out by the Indians as early as 1817. * * *

" The first orchard near Halls Corners was planted on the farm of Edward Burrell about 1801. The seed from which these trees grew was supposed to have been taken from the natural fruit found growing wild in the woods. Probably these natural fruit trees grew from seeds scattered by the Indians. In the orchard of T. B. Wilson, Halls Corners, there is standing today an apple tree said to have been planted by the Indians. Parts of the tree have been grafted to different varieties, and each year it bears four or five kinds of apples. One limb still bears the natural fruit which was small, with red stripes, and almost tasteless. In 1896 it bore 16 barrels of apples."*

According to the foregoing authority, Ontario county has been the birthplace of several varieties of apples. The Tolman originated on the farm of Mr. Thomas Tallman, near Geneva, one of the early settlers who planted seeds from an Indian orchard. Norton's Melon, a fruit of excellent quality, though delicate and difficult to propagate, originated, about 1800, in the orchard of Mr. Chapman, of East Bloomfield. The Northern Spy, an apple occupying the third place in the list of apples of commercial importance, both in the State and in Ontario county, originated in the same orchard also. The Seneca Favorite, a local apple, originated, about 1800, on the farm of Marcus Ansley about five miles southwest of Geneva.

---

* Wilson, C. S. The History of the Apple in New York State. Thesis, Cornell University, 1905.

VALUE OF THE APPLE CROP

The Twelfth Census of the United States, 1900, gives the value of all orchard products for the State of New York as $10,542,272, and of Ontario county as $497,354. The number of apple trees of bearing age at that time was 419,483, and the yield in bushels 933,764. Ontario county occupied fifth place among the counties of the State in the value of orchard products, eighth in the number of bearing apple trees, and seventh in yield of apples.

PURPOSE OF THE 1908 SURVEY

The purpose of the present survey is to show the existing conditions of the apple industrv in Ontario county. The material is arranged from two standpoints:

1. The general distribution of orchards according to the different factors enumerated in the survey.
2. The relation of the different methods in orchard management to yield and income.

From this latter consideration it is hoped that reliable conclusions may be reached concerning the best methods in orchard management.

The value of orchard surveys is taken up in the Appendix, Part II.

COLLECTION OF DATA

During the summer of 1908, Messrs. A. W. McKay and W A. Salisbury made an orchard survey of Ontario county. The data obtained through the courtesy of the farmers and by personal observation were recorded in notebooks containing blanks for this purpose. The accompanying illustration of the blank (p. 171) shows the topics dealt with in the field work.

The yield and income for 1908 were obtained through letters sent out by the Department of Horticulture at Cornell University during the winter of 1908–1909.

METHODS OF TABULATION

Reports from 391 orchards, covering an area of approximately 2700 acres, are used as a basis for the tables. Inasmuch as the data were not complete on all the slips for all the points under consideration, it was

Fruit.......... ORCHARD SURVEY. No..........
..........County CORNELL EXPERIMENT STATION. Date..........19......
Owner..........P. O..........
Location..........When planted..........
Site..........Aspect..........
Soil, type..........Variations..........
Drainage, natural or artificial..........Character..........
Soil management (now and for past 10 years)..........
....
{ If sod, method of treatment } ....
{ If tilled, frequency }
Fertilizers, kind..........Quantity..........Frequency..........
Cover crops..........
Pruning, method..........Frequency..........Character..........
Spraying, mixtures..........Effects..........
No. applications..........Machinery..........
Troubles, Fungi..........
Insects..........Others..........
Present condition..........
Varieties..........
Variety Notes..........

	19......	19......	19......	19......	19..	Acre
Yields......						
Price......						
Income per acre......	$......	$......	$......	$......		

Where and how sold..........
Package used..........Labor..........
General observations..........
..........Observer..........

Planting plan

FIG. 1.—*Survey blank from field notebook*

deemed advisable to tabulate the results from three different groupings of orchards, as follows:

In Group I are placed 161 orchards for which complete returns for yield and income for the years 1904, 1905, 1906, and 1907 are recorded. This grouping is made in order to show the influence of the various factors in orchard condition and management on yield and income per acre. In determining the average yields and incomes per acre, the totals as recorded in the survey sheets have been used, and the mean* (average) per acre is the average used in all tables.

In Group II are included all the available data from the 391 orchards, concerning the distribution of orchards and general orchard management.

Group III consists of all the orchards for which yield and income are reported for 1907 and 1908. The tables based on this group, with one exception, will be found in Part I of the Appendix.

THE GEOGRAPHICAL DISTRIBUTION OF ORCHARDS

The geographical distribution of apple orchards in the county naturally follows the path of the old Indian orchards. The main mass of the orchards is concentrated in the southeastern corner of the county, extending from Orleans, a few miles north of Seneca Castle, southeasterly to Seneca, Halls Corners, and the district north of Bellona, and southwesterly to Gorham. The orchards in this somewhat triangular space comprise 80 per cent of the total orchards whose location is recorded. The orchards near Clifton Springs, Phelps, Shortsville, Hopewell Center, and Canandaigua bring the total for the eastern half of the county up to 89 per cent. Another center of the industry is in the vicinity of East Bloomfield, the home of the Northern Spy, where 5.5 per cent of the orchards are located. A few orchards are scattered in the northwestern part of the county around Victor and Fishers.

GENERAL AVERAGE YIELD AND INCOME FOR THE COUNTY

The general average yield and income for all the orchards in Ontario county comprising Group I are shown in Table 1. The figures for yields show larger returns in the alternate years, but prices are so adjusted that such extremes do not appear in the incomes. The years of heavy yield were 1904 and 1906. An average yield of 79 barrels per acre was produced in 1904, and about 61 barrels per acre in 1906. Much damage was done by hail in 1907, so that the yield for that year reached the very low point of 38 barrels per acre for the orchards of Group I. The four-year average yield for Group I is 58.4 barrels per acre, and the four-year average income is $111.51.

---

* See Appendix, Part II, for an explanation of this term.

TABLE 1. GENERAL AVERAGE YIELD AND INCOME

GROUP I

No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
		1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
161	1,099.1	79.0	56.1	60.6	37.8	58.4	$110 00	$118 10	$114 10	$103 85	$111 51

GROUP III

No. of orchards	Acres	Yield per acre (bbls.) 1907	No. of orchards	Acres	Yield per acre (bbls.) 1908	2-yr. av.	No. of orchards	Acres	Income per acre 1907	No. of orchards	Acres	Income per acre 1908	2-yr. av.
315	1,982	33.6	181	1,176	62.5	44.0	279	1,838	$91 00	182	1,174	$107 00	$97 00

5-yr. av.

Yield	Income
55 bbls.	$105 50

Considering all the orchards for which there are data for yield and income in 1907, the average yield per acre is 33.6 barrels and the average income $91. For 1908 the average yield is again high, amounting to 62.5 barrels per acre. The average income per acre for 1908 is $107. The mean (average) yield per acre for the two years 1907–1908 is 44 barrels, and the mean income for the same period is $97. The influence of the decidedly poor year, 1907, is shown clearly in these figures. More satisfactory results are obtained in the five-year averages, which show a yield of 55 barrels and an income of $105.50 per acre.

DISTRIBUTION OF ORCHARDS ACCORDING TO YIELD AND INCOME

To state the average yield or income per acre does not give an adequate idea of the proportion of the whole group of orchardists getting those returns. Table 2, based on the four-year average yields and incomes, shows the observed and percentage frequency* and percentage distribution of orchards according to yield and income. The orchards are arranged in classes differing by 20 barrels per acre in yield, and $40 per acre in income. The columns headed " Total per cent " are made up of the sums of percentage frequencies of the consecutive classes from the beginning of the table.

TABLE 2. DISTRIBUTION OF ORCHARDS ACCORDING TO FOUR-YEAR AVERAGE YIELD AND INCOME

Yield per acre (bbls.)	Orchards			Income per acre.	Orchards		
	No.	Per cent	Total per cent		No.	Per cent	Total per cent
				Dollars			
0– 19	10	6.2	6.2	0– 39	14	8.7	8.7
20– 39	27	16.8	23.0	40– 79	30	18.6	27.3
40– 59	50	31.0	54.0	80–119	45	27.7	55.0
60– 79	36	22.4	76.4	120–159	39	24.0	79.1
80– 99	27	16.7	93.2	160–199	22	13.6	92.7
100–119	8	5.0	98.1	200–239	10	6.1	98.8
120–140	3	1.8	99.9	240–280	1	.6	99.4

The typical yield per acre, according to this table, is 50 barrels, the middle value of the class 40–59. Thirty-one per cent of the orchards are in this class. Somewhat less than 50 per cent of the orchards are producing more than 60 barrels per acre. The mean yield per acre, based on the data of Table 2, is nearly 60 barrels.

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* See Appendix, Part II, for explanation of terms.

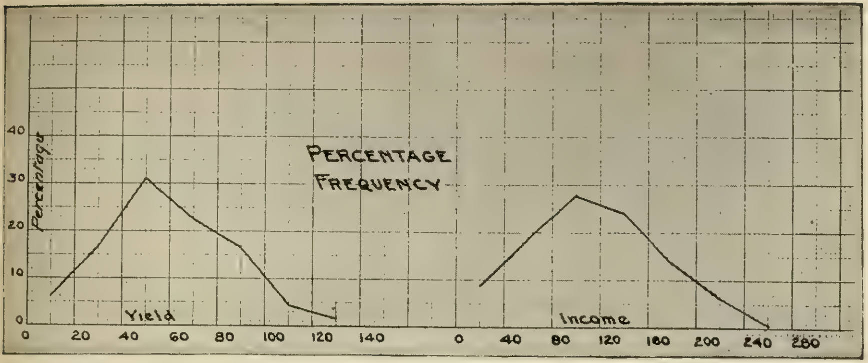

Plate I.—*Percentage frequencies of orchards according to yield and income*

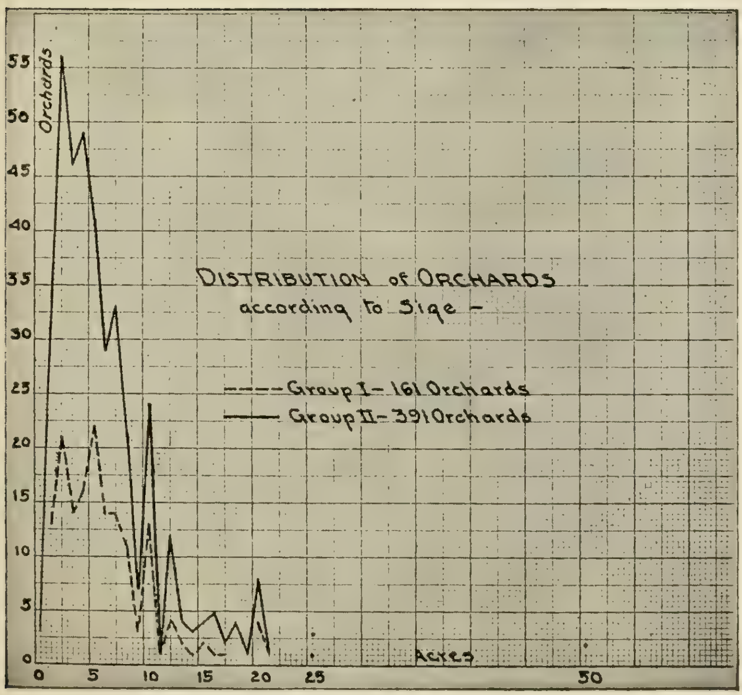

Plate III.—*Distribution of orchards according to size*

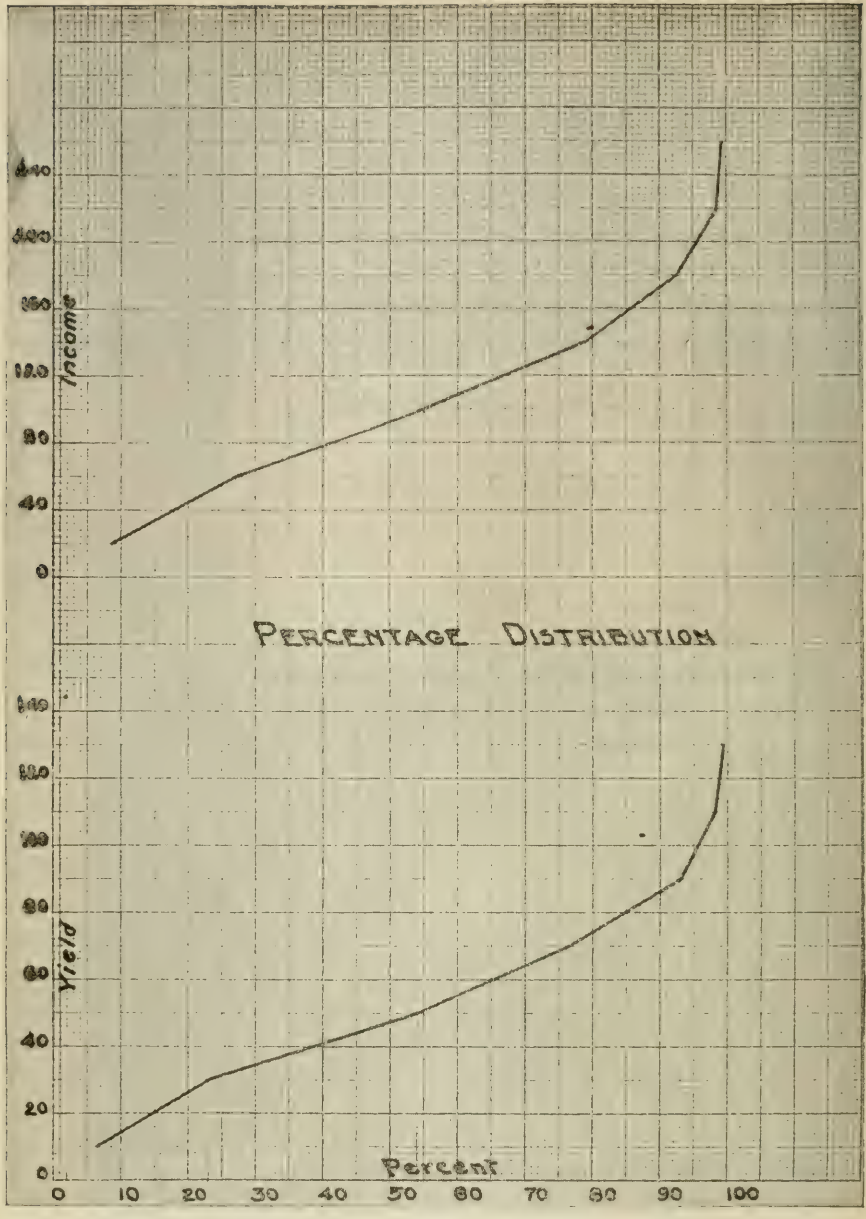

PLATE II.—*Percentage distribution of orchards according to yield and income*

The typical income per acre is $100, the middle value of the class $80–$119. About 28 per cent of the orchards lie in this class. Less than 50 per cent of the orchardists are receiving more than $120 per acre. The mean income per acre, based on the data in Table 2, is $114.50.

The percentage frequencies enumerated in the third and seventh columns of the table are shown graphically in the curves of Plate I; the facts in the fourth and eighth columns of the table are shown in the curves of Plate II, entitled "Percentage Distribution."

SIZE OF ORCHARDS

Distribution of orchards according to size

The individual apple orchards in Ontario county are small. Table 3* shows the distribution of orchards according to size for the 161 orchards

TABLE 3. DISTRIBUTION OF ORCHARDS ACCORDING TO SIZE

Acres	No. of orchards	
	Group I	Group II
.5	....	3
1.5	13	31
2.5	21	56
3.5	14	46
4.5	16	49
5.5	22	41
6.5	14	29
7.5	14	33
8.5	11	21
9.5	3	7
10.5	13	24
11.5	1	1
12.5	4	12
13.5	2	4
14.5	1	3
15.5	2	4
16.5	1	5
17.5	1	2
18.5	0	4
19.5	0	1
20.5	4	8
21.5	1	1
22.5	0	0
23.5	0	1
24.5	0	0
25.5	1	3
50	2	2

---

* In the tabulation the orchards are placed in classes varying in size by one acre, as 0–1, 1–2, etc. The value noted in the table is the mid-value of the class.

of Group I, and the 391 orchards of Group II. The typical size of orchards in Group II is 2 to 3 acres, while that of Group I is 5 to 6 acres. The number of orchards of 2 acres in Group I, however, is but one less than the number of orchards of 5 acres. We may consider, therefore, that the mode* in size of orchards in this county is 2 acres. The median (typical size) in both groups is 5 acres. The mean acreage in Group I is 7 to 8 acres, and in Group II approximately 7 acres. In general, therefore, the distribution in Group I follows that of Group II and may be considered representative of the orchards of the county. Plate III represents graphically the distribution of orchards according to size.

Relation of size of orchard to yield and income

In tabulating the results of the survey, the general run of the figures seems to show that the smaller orchards yield better returns per acre than the larger orchards. Table 4, showing the relation of the size of orchard to yield and income, is based on the four-year average yield and income per acre in order to avoid the yearly fluctuations. The figures for the single-acre classes fluctuate considerably. The 4-acre class (Table 3), especially, is misleading because three out of the sixteen orchards of that class yielded practically nothing. The general trend of the results is more clearly shown by arranging the orchards into classes of 3 acres as shown in Table 4. The averages there given are for orchards of 1 to 3 acres, 4 to 6 acres, etc. The influence of the low yield of the orchards of the 4-acre class (Table 3) is shown in the mean for the 4–6-acre class (Table 4), namely 60.3 barrels, the averages for the 5-acre class and the 6-acre class (Table 3) being approximately 63 and 64 barrels per acre respectively (shown in original data not here presented).

TABLE 4. RELATION OF SIZE OF ORCHARD TO YIELD AND INCOME (4-YEAR AVERAGE)

Acres	No. of orchards	Yield per acre (bbls.)	Income per acre
1– 3	48	65.8	$123.25
4– 6	52	60.3	114.92
7– 9	28	63.3	113.50
10–12	18	53.3	94.65
13–15	6	58.1	130.85
16–19	6	59.8	109.74
20+	3	49.5	106.32

---

* See Appendix, Part II, for a discussion of the mode, median, and mean.

It would seem from the figures that the larger orchards are more likely to be neglected. That there is no inherent reason why a comparatively large orchard should not give excellent results is shown by the exceptional returns from the 14-acre orchard, which produced on the average for four years 88 barrels per acre, with an income of $210 (data not here shown). The larger orchard would warrant the use of better machinery and better methods of orchard management.

On the other hand, the figures of the table may put the small orchard in an unduly favorable light because the greater number of orchards are small. If we had figures for a greater number of large orchards, it is possible that the results would be different. As it is, the table shows that orchards of 3 acres or less are yielding on the average about 66 barrels of apples per acre which bring an income of about $123, while orchards of 20 acres or more yield less than 50 barrels, with an income of $106.32. A comparison with the general averages in Table 1, in which the average yield per acre for the orchards of Group I is 58.4 barrels, and the average income $111.51, shows that the smaller orchards run higher in both yield and income than the general average, while the larger orchards run below.

CONDITION OF ORCHARDS

Only 5 per cent of the orchards are reported " very good " in condition,— a state of affairs that will admit of great improvement. Forty per cent are in good condition, while more than half the orchards are either fair or poor. (See Table 5.)

TABLE 5. CONDITION OF ORCHARDS

Condition	No. of orchards	Per cent
Very good	13	5.0
Good	103	39.6
Fair	99	38.1
Poor	45	17.3

Relation of condition of orchard to yield and income

The comparatively high yields and incomes for the poor orchards in 1904 and 1906, as shown in Table 6, might lead one to think that neglected orchards are profitable. It must be remembered, however, that 1904 and 1906 were years of heavy yield and low prices. Consequently a heavy yield meant a large income despite low prices. The contrast is seen in years of scarcity, 1905 and 1907. The yield of 25.7 barrels in 1905, and of 18.6 barrels in 1907, places the poor orchards in a less favorable, although truer, light. The four-year average yield of 48.4 barrels per acre and income of $81 show that poor orchards are relatively a poor investment.

On the other hand, the better-kept orchards not only produce absolutely higher yields and incomes, but show much less fluctuation in yield in the alternate years. In some cases, even, these orchards show higher incomes in the years of lighter yield than in years of heavy yield. The difference is due, in a measure, doubtless, to the quality of the fruit. The fruit of poor orchards did not bring a good price. Therefore, in years when apples were scarce, the few apples that the poor orchards yielded brought a low price and consequently a low income. The price of apples from the better-kept orchards was much higher in years of scarcity than in years of abundance, and so the income was higher in spite of the low yield. When both yield and quality are high, as seen in the very good orchards for 1905, the income reaches an unusually high point, $243.07. Five orchards are far too few to have much weight in statistics; but they are interesting as indicating what might be expected from orchards that are kept in excellent condition. It will be noticed also that these orchards produced their heaviest yield in what may be called an " off " year, so that they gained the advantage of high prices.

The orchards classed as " good " and " fair " give results that are more valuable because based upon larger numbers. All the average yields and incomes of orchards in good condition run considerably higher than the general averages for the same years as shown in Table I, whereas the same figures for orchards in fair condition, with four exceptions, run considerably below the general average. With the exception of the yield in 1905, all averages for " fair " are below those for " good." The figures in Table 6, therefore, show that it pays well to keep an orchard in good condition:

TABLE 6. INFLUENCE OF CONDITION OF ORCHARD ON YIELD AND INCOME

Condition	No. of orchards	Acres	Yield in barrels per acre					Income per acre				
			1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
Very good...	5	44.5	87.7	99.8	64.3	57.0	**77.2**	$151 34	$243 07	$128 39	$165 19	**$171 99**
Good........	50	378.0	89.2	57.7	69.6	43.0	**64.9**	127 93	125 33	133 32	117 47	**126 01**
Fair.........	46	255.5	74.6	59.7	55.2	40.6	**57.5**	100 89	121 51	99 82	111 06	**108 32**
Poor........	9	44.0	73.6	25.7	55.6	18.6	**48.4**	115 57	48 83	109 29	50 26	**80 99**

ASPECT OF ORCHARDS

By far the greatest number of orchards of the county are reported as sloping toward the east; the next largest group slope toward the west.

The following table (7) shows the distribution of the orchards according to aspect for the 357 orchards for which this point is reported:

TABLE 7. DISTRIBUTION OF ORCHARDS ACCORDING TO ASPECT

Aspect	Orchards	
	No.	Per cent
East	163	45·7
West	65	18.2
North	31	8.7
South	13	3·6
East and west	19	5·3
Northeast	8	2.2
Level	26	7·3
Miscellaneous	32	9·0

Relation of aspect to yield and income

Table 8 shows the influence of slope on the yield and income per acre. The orchards that are situated on level ground have the highest yield, about 68 barrels on the average for four years, and highest income, $133, which are considerably above the general average, while those sloping to the west are lowest in the scale.

TABLE 8. RELATION OF ASPECT TO YIELD AND INCOME PER ACRE

Aspect	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
			1904	1905	1906	1907	**4-yr. av.**	1904	1905	1906	1907	**4-yr. av.**
Level	15	89.5	107.7	52.9	67.4	42.4	**67.6**	$158 51	$128 87	$127 24	$116 66	**$132 82**
North	15	107.8	75.0	55.7	55.5	41.4	**56.9**	102 47	111 62	107 00	115 00	**109 02**
West	28	172.3	72.2	48.7	52.6	36.1	**52.4**	104 07	86 80	85 32	86 62	**90 70**
East	62	388.6	64.6	56.6	62.3	37.2	**55.2**	92 37	122 30	118 66	107 13	**110 11**

ELEVATION

Distribution of orchards according to elevation

When the orchard survey was made, the position of the orchards was recorded on the topographical sheets for Ontario county, from which sheets the elevation was determined. It is impossible to give more than a rough estimate of the elevation by this method, for it is quite likely that the figures spread over more territory than the orchard, and in places where there is considerable grade exact elevation could not be ascertained.

Moreover, the groups of orchards varying in elevation by a difference of only 20 feet are too small to admit of tabulation. They have been combined, therefore, into groups differing by 100 feet. The elevation varies from 500 to 1100 feet. The typical or prevailing elevation is between 800 and 900 feet. Over 50 per cent of the orchards are found at elevations from 800 to 1000 feet.

TABLE 9. DISTRIBUTION OF ORCHARDS ACCORDING TO ELEVATION

Elevation (ft.)	Orchards	
	No.	Per cent
500– 600	29	10.6
600– 700	27	9.9
700– 800	49	17.9
800– 900	81	29.4
900–1000	61	22.3
1000–1100	27	9.9

Relation of elevation of orchards to yield and income

The irregularities in the figures of Table 10 seem to show that there is no relation between elevation of orchard and yield and income. The four-year average yields per acre for the three groups 700–800 feet 800–900 feet, 900–1000 feet, which contain a sufficient number of orchards to be of statistical value, are practically the same, 56 barrels per acre. There is slightly more variation in the incomes, which range from $101 to $108. The maximum yield, 78 barrels, and maximum income, $144, are found at the lowest elevation. The next highest values are found at the highest elevation. In both these cases, however, the number of orchards upon which the figures are based is hardly sufficient to give much importance to the results.

TABLE 10. RELATION OF ELEVATION OF ORCHARDS TO YIELD AND INCOME

Elevation (ft.)	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
			1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
500– 600	9	68.0	99.9	73.0	83.1	60.2	78.1	$122 09	$146 04	$137 88	$170 62	**$144 16**
600– 700	9	113.0	73.0	54.3	63.7	46.7	59.4	96 47	140 58	127 54	137 68	**125 57**
700– 800	24	138.1	73.1	61.1	63.0	30.1	56.8	104 85	116 08	120 75	84 00	**106 42**
800– 900	36	214.5	83.0	58.4	55.5	29.1	56.5	115 83	111 61	108 96	70 44	**101 71**
900–1000	34	247.8	84.0	48.8	59.8	35.6	56.9	114 48	102 05	112 13	105 17	**108 46**
1000–1100	11	79.0	89.0	62 5	69.7	52.1	68.3	138 28	157 06	123 33	127 13	**136 46**

AGE OF TREES

According to Table 11 the typical age of apple trees in Ontario county is between 30 and 34 years, orchards of such age comprising 23.4 per cent of the total. About 79 per cent of the orchards contain trees 30 years old or more, and 14 per cent are 50 years old or more. Orchards of young trees are comparatively few.

TABLE 11. Distribution of Orchards According to Age of Trees*

Age	Orchards	
	No.	Per cent
1– 9 years	7	1.7
10–14 years	10	2.4
15–19 years	7	1.7
20–24 years	18	4.3
25–29 years	46	11.0
30–34 years	98	23.4
35–39 years	78	18.6
40–44 years	65	15.5
45–49 years	32	7.6
50+	58	13.8

* The large total (419) for orchards in this table is due to the fact that some of the orchards, containing trees of various ages, were duplicated in the different groups.

Relation of age of trees to yield and income

The greatest four-year average yield occurs in the group of orchards between 25 and 29 years of age, which produced 65 barrels per acre. The orchards between 50 and 59 years old produced practically the same amount. The four-year average income for these groups, however, is exceeded by the group of orchards between 40 and 44 years of age, for which the four-year average income is $128. Trees under 25 years and over 60 years do not produce as much as the general average yield. These low figures, however, may be due in part to the small number of orchards in the groups.

The low yield and income for the group of orchards from 45–49 years old are due, doubtless, to the condition which is so common, namely, neglect. In many an old orchard close planting and bad pruning have resulted in producing trees with tops forming a mass of interlocking branches which cut off the light and air from the soil and lower part of the tree, killing the lower branches and reducing the bearing surface of the tree to a few high spurs inaccessible alike to sprayer and picker. The remedy for such conditions is complete renovation.

TABLE 12. RELATION OF AGE OF TREES TO YIELD AND INCOME PER ACRE

When planted	Age (years)	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
				1904	1905	1906	1907	**4-yr. av.**	1904	1905	1906	1907	**4-yr. av.**
1884-1888	20-24	8	63.8	72.5	33.7	62.6	37.2	**51 5**	$107 16	$72 30	$113 27	$86 64	**$94 84**
1879-1883	25-29	16	102.0	90.3	51 5	79.5	40.1	**65.3**	124 81	111 63	125 90	99 09	**115 36**
1874-1878	30-34	49	340.6	88.7	63.3	50 3	36 5	**59 7**	125 82	128 52	97 68	100 64	**113 16**
1869-1873	35-39	36	230.0	83.3	61.8	62.7	38.6	**61 6**	126 13	133 57	113 89	106 47	**120 01**
1864-1868	40-44	29	228.0	70.8	63.8	58.5	46.4	**59 9**	105 92	147 65	121 14	137 89	**128 15**
1859-1863	45-49	8	90.0	73.1	26.2	62.0	16.9	**44 6**	58 72	52 61	117 62	46 98	**68 98**
1849-1858	50-59	17	81.3	85.0	77.2	58.7	38.8	**64.9**	128 75	139 91	111 73	107 75	**122 03**
Before 1849...	60+	9	63.0	78.0	46.4	56.0	28 4	**52 2**	120 00	99 20	108 10	72 90	**100 05**

VARIETIES

The distribution of varieties of apples grown in Ontario county follows in general that of the State as given in "The Apples of New York."* Of the 378 orchards for which the varieties were reported, 372 contained Baldwins, 344 Greenings, 180 Northern Spy, 118 Tompkins King. These, together with Roxbury (Russet), are the leading varieties, with the Baldwin and Greening (Rhode Island) far in the lead. Other varieties grown, named in order of importance, are the Esopus (Spitzenberg), Hubbardston, Wagener, Ben Davis, Fall Pippin, Tolman (Sweet), Pumpkin (Pound) Sweet, Maiden Blush, Wealthy, Fallawater, Westfield, Swaar, Stark, Gravenstein, Primate, Rome (Beauty), Red Astrachan, McIntosh, Twenty Ounce, Fameuse, Yellow Bellflower, Black Gilliflower, Jonathan, Sutton (Beauty), Smokehouse, Sweet Winesap, Green Sweet, Late Strawberry, Vandervere, Pewaukee, Arkansas, Oldenburg, Early Harvest, Gano, Longfield, Lady Sweet, Rambo, Yellow Transparent, and Tetofsky. There were fifty-four varieties reported, but several were mentioned but once.

PLANTING PLAN

About 91 per cent of the orchards are planted on the square plan. (See title page.) Only one orchard is recorded as planted hexagonally, and one according to the quincunx system. The others are planted in rectangles. The typical distance at which the orchards are planted is

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* Beach, S. A. The Apples of New York. 2 Vols. Report of New York State Agricultural Experiment Station, 1903.

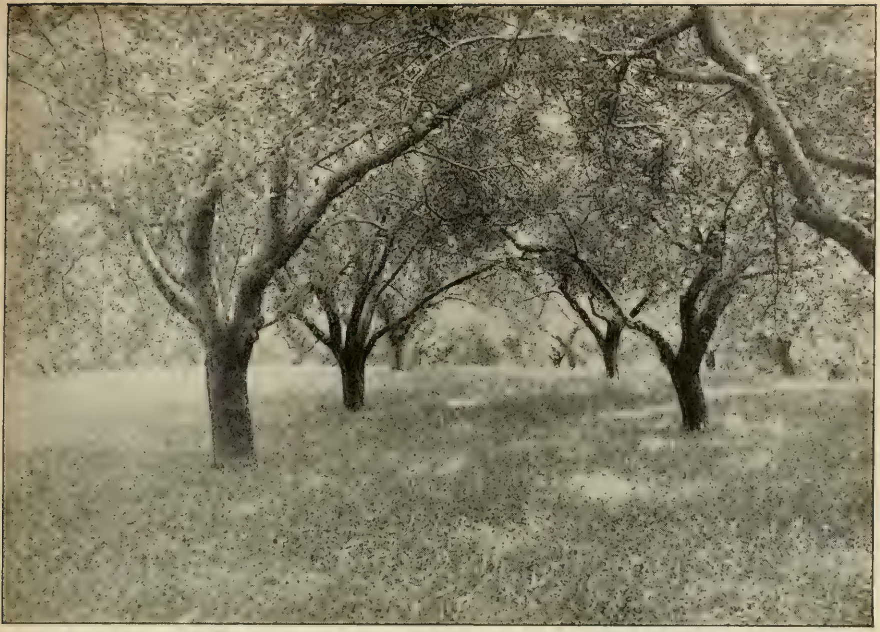

FIG. 18.—*This orchard illustrates the evils of close planting*

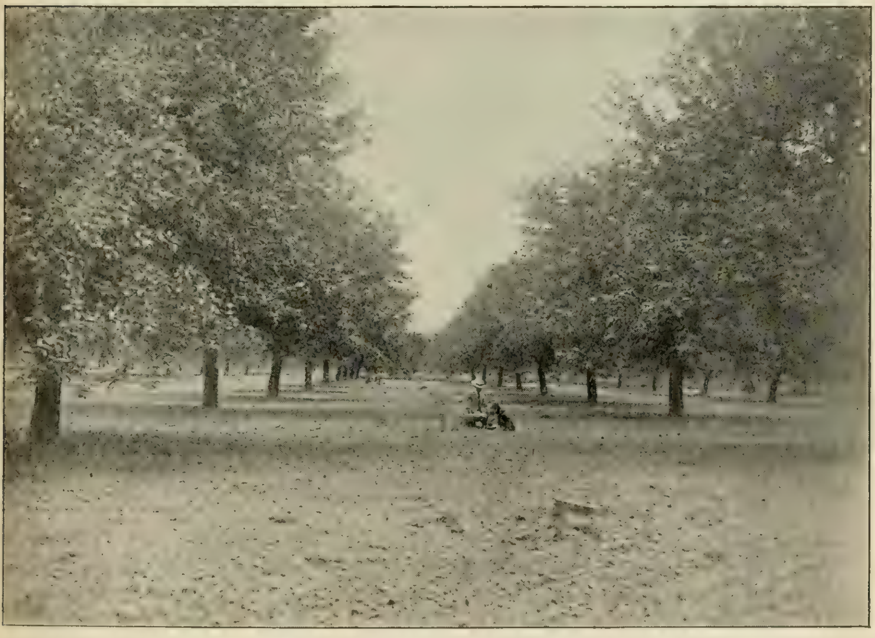

FIG. 19.—*In this closely planted orchard alternate rows have been cut out, diagonally, in time to save the permanent trees*

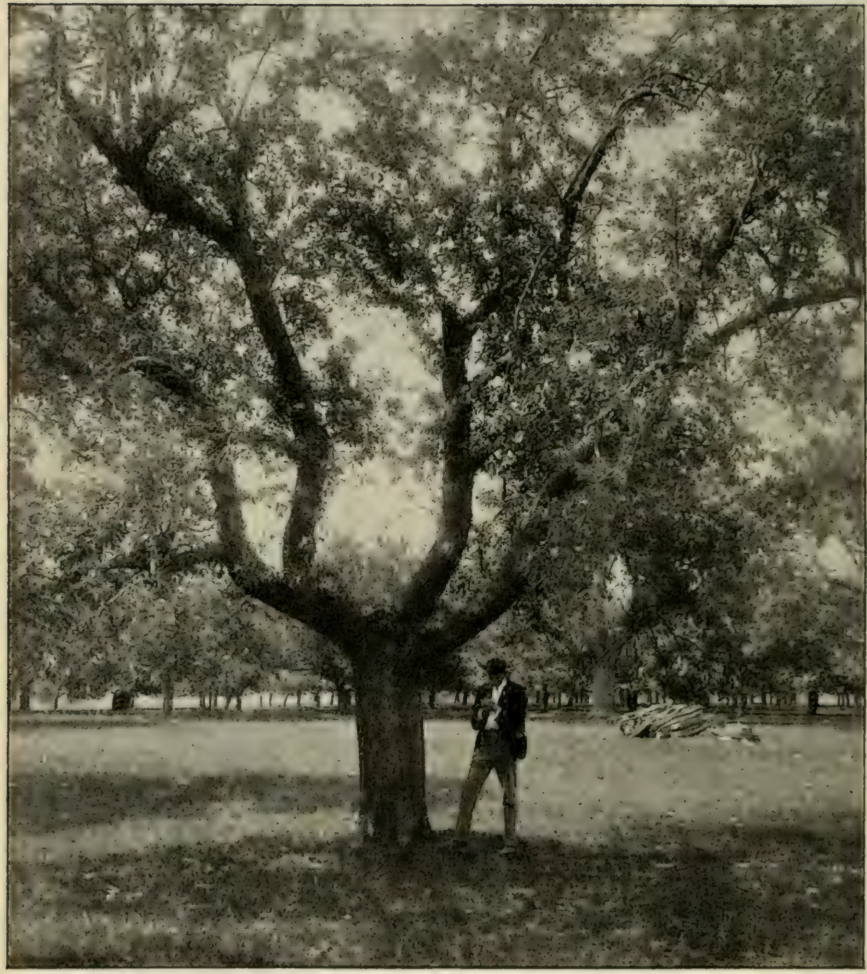

FIG. 20.—*This illustrates the "trimming up" type of pruning, which constantly tends to raise the head*

33 x 33 ft. Table 13 shows the distribution of orchards according to the system of planting, and the distance apart at which the trees are planted:

TABLE 13. SYSTEMS OF PLANTING

System	Distance	Orchards	
		No.	Per cent
Square	20 x 20	2	.5
	25 x 25	4	1.1
	30 x 30	47	12.7
	32 x 32	23	6.2
	33 x 33	161	43.5
	35 x 35	31	8.4
	36 x 36	8	2.2
	38 x 38	7	1.9
	40 x 40	49	13.2
	45 x 45	3	.8
	50 x 50	3	.8
			91.3
Rectangular	30 x 33	2	.5
	30 x 35	4	1.1
	30 x 40	2	.5
	Miscellaneous	22	6.0
			8.1
Quincunx	46 x 46	1	.3
Hexagonal	40 x 40	1	.3

Relation of distance of trees to yield and income

Table 14 shows that there is little relation between the distance at which trees are planted and the yield and income per acre. Slightly the best yield occurs when the trees are planted 35 feet apart, but the best income is found at 33 feet, which, however, is below the general average for the orchards under consideration. The differences in the four-year average yields and incomes for the different groups are comparatively slight, with the exception of the income for the group of orchards planted 30 x 30 feet, which falls far below the general average.

TABLE 14. RELATION OF PLANTING DISTANCE TO YIELD AND INCOME

Distance	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
			1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
30 x 30	20	211.0	94.0	47.3	61.3	27.9	**57.6**	$107 27	$97 59	$115 01	$66 27	**$96 54**
33 x 33	67	374.9	83.4	59.2	59.1	36.6	**59.6**	120 90	117 20	110 00	104 00	**110 02**
35 x 35	16	129.0	87.0	46.9	68.6	37.6	**60.0**	127 65	91 68	119 52	90 28	**107 28**
40 x 40	25	185.0	62.2	66.2	67.8	35.0	**57.8**	86 00	129 50	117 00	97 00	**107 32**

If trees are planted too close together, when they reach maturity they become so crowded that light and air are excluded; the branches are forced upward in their search for sunlight, producing a high head and reducing the bearing surface to a small inaccessible area in the tops of shade trees (see Fig. 18). The dense shade results in fruit of poor quality, so that a low income per acre occurs at a time when the trees should be at their best.

Until trees grow large enough to begin to crowd, the yield per acre will be larger when the trees are planted closely, because there are more trees per acre. But if large crops from mature trees are to be expected, the trees must be planted farther apart. In such planting, until the period of full bearing is reached the yield per acre will not be so great, owing to the few trees per acre.

PRUNING

The general practice in Ontario county is to prune every year, 58 per cent of the orchards being treated in that way. (See Table 15.) Sixteen per cent are pruned occasionally. The fact that pruning in 53 per cent of the orchards is only fair, and in over 23 per cent is poor, does not speak well for the production of first-class apples. Less than 24 per cent of the orchards are well pruned. The chief method of pruning is to cut out the suckers and deadwood, and perhaps to thin a little. Some growers trim the trees a little more. Only about 2 per cent make an attempt to keep the trees open headed.

TABLE 15. GENERAL PRACTICE IN PRUNING

	Orchards	
	No.	Per cent
Frequency		
Every year	212	58.1
Once in 2 years	81	22.2
Once in 3 years	12	3.3
Occasionally	60	16.4
Character		
Good	73	23.8
Fair	163	53.1
Poor	71	23.1
Method		
Thinned	208	76.5
Trimmed	56	20.6
Open headed	5	1.8
Headed back	3	1.1

SOIL TYPES

The chief soil types are the gravelly and sandy loams. About 60 per cent of the orchards come under these headings. Table 16 shows the distribution of the orchards according to soil types:

TABLE 16. DISTRIBUTION OF ORCHARDS ACCORDING TO SOIL TYPES

Soil type	Orchards	
	No.	Per cent
Loam	60	20.2
Gravelly loam	58	19.5
Gravelly sandy loam	22	7.4
Sandy loam	39	13.1
Fine sandy loam	62	20.9
Clay loam	46	15.5
Silt loam	10	3.4

Relation of soil type to yield and income

Table 17 shows that it is the lighter, well-drained soil types, such as the gravelly and sandy loams, which produce the highest yields and incomes. The highest average yield, 63.3 barrels, occurs on the sandy loam. The lowest yields and incomes are produced on the heavier soils, the clay and silt loams, which produce about 49 barrels per acre with an income of $78 to $81—figures much below the general average.

TABLE 17. RELATION OF SOIL TYPE TO YIELD AND INCOME PER ACRE

Soil	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
			1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
Loam	31	190.8	74.0	49.5	73.0	38.0	**58.6**	$104 00	$103 00	$126 00	$101 00	**$108 50**
Gravelly loam	12	201.0	81.0	49.5	60.0	45.0	**58.9**	98 00	110 00	117 00	125 00	**112 50**
Gravelly sandy loam	11	48.5	68.0	53.0	61.0	37.8	**54.9**	104 00	116 00	120 00	112 00	**113 00**
Sandy loam	18	119.9	99.0	62.0	51.5	40.5	**63.3**	116 50	123 50	101 80	112 00	**113 85**
Fine sandy loam	24	120.5	68.0	65.0	55.0	32.0	**55.0**	112 00	120 00	106 50	97 00	**108 90**
Clay loam	19	145.0	66.0	45.0	42.2	24.6	**49.5**	88 00	97 00	76 00	64 50	**81 40**
Silt loam	7	48.5	62.5	39.0	51.9	35.0	**49.6**	83 00	78 60	90 00	62 00	**78 40**

DRAINAGE

Since much of the soil in Ontario county contains considerable amounts of sand and gravel, well-drained soil types abound. Moreover, the contour of the land in many cases aids in the natural draining of the soil. Yet 50 per cent of the orchards are classified as having artificial drainage, which consists almost wholly of tile drains, and about 14 per cent more are partially tile-drained. The large proportion of tile drainage in the county is due, no doubt, to the influence of John Johnston,* who was the first to use tile drains in America. He began laying tile drains on his farm near Geneva in 1837, and in the course of thirty years laid between sixty and seventy miles of them on his farm. Notwithstanding the extensive use of tile drains, only about half the orchards are reported as being well drained. Table 18 summarizes the condition of drainage as reported in the survey:

TABLE 18. DRAINAGE

Character	Natural	Artificial	Both	Total	Per cent
Good	50	92	20	162	49.3
Fair	60	60	14	134	40.7
Poor	11	16	6	33	10.0
Total	121	168	40	329	
Per cent	36.8	51.1	12.1		

Type	Orchards	
	No.	Per cent
Natural	138	36.2
Artificial	191	50.0
Both	53	13.8

Artificial drainage†	No.
Tile	234
Mains	76
Mains and laterals	79
Ditch	7
Stone	6

† Three of the orchards are duplicated in this group, which accounts for the greater number of artificially drained orchards.

Relation of drainage to yield and income

A naturally well-drained soil gives the best results. The four-year average yield in such orchards, as shown in Table 19, is in round numbers

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* Fippin, E. O. Drainage in New York. Bulletin 254, Cornell University Agricultural Experiment Station.

67 barrels per acre, as contrasted with 56 barrels for those orchards which have to resort to artificial means of drainage. The income, also, is much higher for the naturally drained soils.

TABLE 19. RELATION OF TYPE OF DRAINAGE TO YIELD AND INCOME

Type	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
			1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
Natural.....	48	271.8	95.2	58.5	71.2	42.4	66.8	$121 57	$123 51	$126 15	$114 30	**$121 38**
Artificial.....	88	660.9	71.5	55.5	59.0	36.5	55.6	102 00	117 80	116 00	103 85	**109 91**
Both........	23	146.5	83.3	56.1	50.6	35.7	56.4	129 46	113 36	89 48	92 75	**106 26**

Table 20 shows clearly the necessity of good drainage, whether it be natural, artificial, or both. If the soil is not naturally good in drainage, one should resort to artificial drainage. There is no use in laying artificial drains, however, unless the work is well done and the systems kept in good working order. If the drainage is poor, the fact that there are miles of tile drain in the ground will be of no avail.

The contrast between fair and good drainage is most easily seen in the four-year averages. The income for all *fair* orchards is considerably below the general average, as is also the yield per acre, with the exception of the group of orchards with fair natural drainage. Although the yield for this latter group is high, the very low income shows that the quality is poor. The incomes for all orchards, on the other hand, which have good drainage are much higher than the general average, and are practically the same for the different types of drainage. The yields also run above the average, with the exception of good artificial drainage, which is slightly below. Clearly the type of drainage is not so important as the character.

TABLE 20. TYPE AND CHARACTER OF DRAINAGE IN RELATION TO YIELD AND INCOME

Type	Character	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
				1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
Natural...	Good...	**16**	122.0	93.9	54.5	68.0	45.2	**65.4**	$124 53	$111 73	$124 18	$126 74	**$121 80**
	Fair....	**24**	99.8	97.1	56.3	68.8	33.9	**64.0**	99 86	107 91	111 19	85 38	**101 09**
Artificial..	Good...	39	258.9	69.0	64.0	57.0	41.5	**57.9**	103 95	142 10	117 27	120 09	**120 85**
	Fair....	33	286.5	73.3	43.7	61.3	31.3	**52.4**	93 50	94 47	112 18	87 06	**96 80**
Both.....	Good...	8	56.0	78.1	73.0	57.6	39.0	**61.4**	127 11	139 58	111 85	112 40	**122 73**
	Fair....	8	40.0	98.6	40.8	35.1	30.0	**51.1**	144 34	111 25	67 33	89 25	**103 04**

SOIL MANAGEMENT

General practice

The general practice in soil management in the county is the sod method. Table 21 shows that about 56 per cent of the orchards are left in sod 5 years or more, 41 per cent are left in sod 10 years or more, while only 14 per cent are tilled 5 years or more:

TABLE 21. SOIL TREATMENT

Treatment	Orchards		
	No.	Per cent	
Tilled 10 years or more	37	9.5	14.4
Tilled 5-10 years	19	4.9	
Tilled 3 out of 5 years	42	10.8	29.8
Sod 3 out of 5 years	74	19.0	
Sod 5–10 years	57	14.6	55.8
Sod 10 years or more	161	41.2	

Relation of soil management to yield and income

From the fact that so large a percentage of orchards are left in sod, we should expect this type of management to be most profitable, for in the long run people are quite likely to follow methods that bring the greatest returns. In this case, however, the greatest return for the least labor seems to be the governing principle.

TABLE 22. RELATION OF SOIL TREATMENT TO YIELD AND INCOME

Treatment	No. of orchards	Acres	Yield per acre (bbls.)					
			1904	1905	1906	1907	4-yr. av.	
Tilled 10 years or more	12	125	58.4	66.6	49.2	49.8	56.0	60.9
Tilled 5–10 years	7	71.5	87.1	71.5	73.4	46.0	69.5	
Tilled 3 out of 5 years	21	181	82.7	46.0	65.3	37.0	57.7	
Sod 3 out of 5 years	34	224.8	75.3	57.1	49.5	40.3	55.6	
Sod 5–10 years	31	178.1	83.1	67.0	68.4	34.3	63.2	59.1
Sod 10 years or more	57	325.8	84.7	48.6	63.0	31.4	56.9	

Treatment	Income per acre					
	1904	1905	1906	1907	4-yr. av.	
Tilled 10 years or more	$74 46	$168 91	$116 85	$154 49	$128 68	133.00
Tilled 5–10 years	114 99	174 79	144 92	127 75	140 61	
Tilled 3 out of 5 years	95 41	99 11	125 89	99 03	104 86	
Sod 3 out of 5 years	113 13	114 97	94 70	112 98	108 94	
Sod 5–10 years	127 07	130 76	68 38	89 70	103 98	102.55
Sod 10 years or more	119 89	91 52	111 16	81 85	101 11	

Table 22 shows that sod treatment is not the most profitable. Although the four-year average yield of 63 barrels for orchards in sod 5 to 10 years is considerably higher than the general average, the yield for orchards which have been in sod 10 years or more is only 57 barrels per acre, which is somewhat below the general average. The average yield for all orchards in sod 5 years or more is 59.1 barrels per acre, a figure but slightly above the general average.

The yield alone, however, will not give an adequate idea of the value of the crop. The four-year average income for all orchards that have been in sod 5 years or more is $102.55, which is below the general average, $111.51.

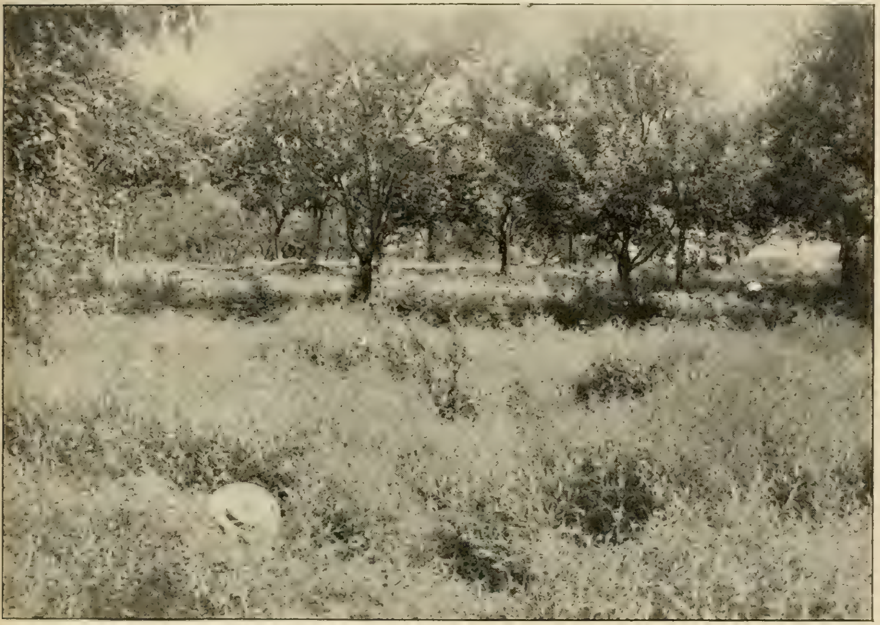

FIG. 21.—*Hairy vetch as a cover crop sown early in July, photographed in November of same year*

The yield for orchards tilled 5 to 10 years is 69.5 barrels per acre, a very much higher return than the general average, 58.4 barrels, although the four-year average yield for orchards tilled 10 years or more is 56 barrels per acre, a figure somewhat below the general average and also less than the yield for orchards in sod 5 years or more.

Again, the income per acre serves as a better index of the value of different methods of soil treatment. The income for the orchards tilled 5 years or more, is the only figure above the general average. The figures are $128.68 for orchards tilled 10 years or more, $140.61 for orchards tilled 5 to 10 years, and $133 for all orchards tilled 5 years or more.*

The alternate treatment of tillage and sod does not seem to be so profitable. The figures for both yield and income are below the general average. As for sod treatment, the indications are that the longer an orchard is in sod, the worse it is. It must be understood, however, that there are well-managed sod orchards that are giving very good returns; and for certain locations, such as steep slopes, it is the only practicable method of treatment. In general, tillage brings better results.

Management of sod orchards

In considering the management of sod orchards, the orchards have been divided into three groups:

1. Orchards that have been in sod 5 years or more.
2. Orchards that have been in sod part of the time and cultivated part of the time.
3. All orchards that have been in sod at all equal the sum of 1 and 2.

Table 23 shows the distribution of orchards according to type of pasturage. The typical management of sod orchards is "no pasture." This is especially true of orchards that are cultivated part of the time, about 58 per cent of which have no pasture. Over 36 per cent of the total sod orchards are not pastured. Hogs are the chief animals pastured in orchards, although sheep are used to a considerable extent.

TABLE 23. PASTURAGE OF SOD ORCHARDS

Pastured with	Sod		Partly cultivated		Total sod	
	No. of orchards	Per cent	No. of orchards	Per cent	No. of orchards	Per cent
No pasture	56	25.5	67	57.8	123	36.6
Hogs	41	18.6	19	16.4	60	17.9
Sheep	27	12.3	7	6.0	34	10.1
Hogs and sheep	25	11.4	8	6.9	33	9.8
Cattle	22	10.0	6	5.1	28	8.3
General	49	22.2	9	7.8	58	17.3
Total	220		116		336	

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* The figures for the tilled orchards serve as an indication of results that may be obtained by careful methods of cultivation; but there are too few orchards considered to give very much weight to the averages.

Relation of pasturage to yield and income

From Table 24 it is most evident that cattle are very poor animals to have in an orchard. The damage that they do to both trees and fruit is shown in the extremely low yields and incomes, the four-year average yield being 32.9 barrels per acre, and the income $55.42, only about half the general average.

Next to cattle is the miscellaneous group, which includes orchards pastured chiefly with cattle and horses. The figures here are somewhat higher, probably due to the fact that some of the orchards were pastured with sheep or hogs but had one cow or horse in them, which threw them into the miscellaneous group. Although the four-year average yield of 59.6 barrels per acre for the miscellaneous group is a little higher than the general average, the four-year average income, $97.81, is considerably below the general average, showing that the quality of fruit was low.

TABLE 24. RELATION OF PASTURAGE TO YIELD AND INCOME

Treatment	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
			1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
Sod 5 years or more:												
No pasture......	26	128.5	83.0	59.3	74.5	29.5	**61.6**	$123 90	$113 79	$132 28	$79 32	**$112 32**
Hogs...........	16	50.3	90.0	68.1	66.5	35.1	**64.9**	110 00	144 85	126 35	94 32	**118 88**
Sheep..........	10	90.5	94.6	32.2	72.2	32.2	**57.8**	138 00	65 50	139 17	85 10	**106 94**
Hogs and sheep..	16	102.1	97.0	53.8	61.6	33.5	**61.5**	157 24	125 30	111 76	94 98	**122 32**
Cattle..........	6	28.5	43.2	51.5	25.0	11.9	**32.9**	62 05	83 40	44 51	31 72	**55 42**
Miscellaneous...	14	104.0	72.8	65.7	60.3	39.5	**59.6**	96 20	116 53	88 00	90 50	**97 81**
Partly cultivated:												
No pasture......	30	237.3	82.1	43.5	60.6	34.4	**55.2**	101 32	91 50	111 80	93 10	**99 43**
Hogs...........	13	59.0	67.0	56.6	66.8	39.2	**57.4**	117 28	112 00	139 23	111 28	**119 95**
Sheep..........	5	56.0	85.8	88.5	24.7	53.7	**63.2**	118 10	187 56	49 06	159 13	**128 46**
Hogs and sheep..	4	26.0	68.9	63.2	87.1	55.1	**68.6**	104 02	136 00	157 15	165 32	**140 62**
Total sod orchards:												
No pasture......	56	365.8	82.4	48.9	65.4	33.2	**57.5**	109 11	99 29	119 08	88 19	**103 92**
Hogs...........	29	109.3	77.5	61.9	66.7	37.5	**60.9**	113 83	126 90	133 35	103 48	**119 39**
Sheep..........	15	146.5	91.0	53.6	54.0	40.4	**59.8**	130 23	112 18	104 72	113 40	**115 13**
Hogs and sheep..	20	128.1	91.3	55.7	66.8	37.9	**62.9**	146 43	111 70	120 98	109 11	**122 05**
Cattle..........	6	28.5	43.2	51.5	25.0	11.9	**32.9**	62 05	83 40	44 51	31 72	**55 42**
Miscellaneous...	14	104.0	72.8	65.7	60.3	39.5	**59.6**	96 20	116 53	88 00	90 50	**97 81**

The best method of treatment of sod orchards, according to Table 24, is to use them as a pasture for hogs and sheep. For this type of pasture, the four-year average yields in the different groups, sod 5 years or more, partly cultivated, and total sod orchards, range from 61.5 barrels per acre to 68.6 barrels per acre, while the incomes range from $122.05 to $140.62. Both the highest yield and highest income occur in the orchards that are cultivated part of the time.

The question of the relative merits of sheep and hogs seems to depend on whether or not the orchards are cultivated. Orchards that are partly cultivated and pastured with sheep yield (four-year average) 63 barrels per acre, with an income of $128, while orchards of the same group pastured with hogs yield 57 barrels per acre, with an income of $120. On the other hand, orchards that are in sod continuously but pastured with hogs produce 65 barrels per acre, with an income of $119; orchards in the same group pastured with sheep yield about 58 barrels per acre, with an income of $107. In this case the value of a hog as a cultivator is clearly shown. When the total number of sod orchards is considered, the figures for orchards pastured with hogs run a little higher than for those pastured with sheep.

FERTILIZERS

General practice

The use of manure or fertilizer of some sort is quite general. There are only three orchards reported as neither fertilized nor pastured. Were the orchards classified on this basis, however, it would be misleading, for orchards that receive but a little manure at rare intervals yield as little as if they received none. Those that are pastured with but one or two animals occasionally, and receive no other manure, give low returns. All such orchards have been considered as not being fertilized at all, with the result that 77 orchards out of 379 are receiving practically no fertilizer.

TABLE 25. Distribution of Orchards According to Fertilizers Used

Fertilizer	Orchards	
	No.	Per cent
None	77	20.3
Stable manure	205	54.1
Stable manure and cover crop	40	10.6
Stable manure and commercial fertilizer	33	8.7
Stable manure with cover crop and commercial fertilizer	10	2.6
Commercial fertilizer	3	.8
Commercial fertilizer and cover crop	9	2.4
Cover crop	2	.5

Table 25 shows the distribution of orchards according to the kinds of manure used, stating the number and percentage of orchards to which each is applied. The chief manure used is stable manure, a total of 288 growers (76 per cent) using it either alone, or in combination with commercial fertilizer or green manure or both. Commercial fertilizer alone is used to a very slight extent; and, even in combination with other manures, its use is not very general, amounting to only about 14 per cent. Wood ashes, which are included under the head of commercial fertilizers, were used in about one third of these orchards. Two thirds of this latter group were treated with a combination of phosphoric acid and potash, and less than one third with phosphoric acid alone. The usual rate at which the fertilizer is applied is 500 pounds per acre, and it is generally applied every year.

Cover crops are used a little more extensively than commercial fertilizers, and occur in all in about 16 per cent of the orchards. Of these, about one third are sown to leguminous crops, one third to non-leguminous crops, and one third to a combination of both.

Relation of fertilizers to yield and income

It pays to fertilize orchards. Those that were not fertilized (except with small quantities of manure at rare intervals, or pastured to slight extent) are far below the general average in yield and income, producing on the average for four years 44 barrels per acre, and an income of $71.54. (See Table 26.) Those to which stable manure was applied brought returns slightly above the general average. That the averages in this group do not run higher is due to including under this head all orchards to which stable manure has been applied, except in quantities less than five loads per acre, at rare intervals. Table 28 gives a much better idea of the benefits to be gained by applying stable manure. From the data at hand, it would appear that the combination of commercial fertilizer with stable manure produces better results than using a cover crop and stable manure, the yield of the former being 58 barrels and the income $125.95 per acre, while that of the latter is 56.3 barrels, and $108.98 per acre.

TABLE 26. Relation of Fertilizer to Yield and Income

Fertilizer	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
			1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
None........	25	103.5	64.3	39.0	48.4	22.6	**43.6**	$80 78	$63 67	$84 17	$57 54	**$71 54**
Stable manure	83	506.4	83.6	58.5	62.7	35.0	**59.9**	122 98	116 28	117 65	96 55	**113 38**
Stable manure and commercial fertilizer.....	17	198.0	65.8	58.6	57.3	50.2	**58.0**	104 80	135 36	118 63	145 00	**125 95**
Stable manure and cover crop.......	24	159.8	71.5	57.2	49.2	47.4	**56.3**	95 87	120 24	94 06	125 76	**108 98**

Stable manure

Correlation of quantity and frequency of application.— The extensive use of stable manure enables one to learn something concerning the correlation of quantity with the frequency of application. When very little manure is used, it is applied at rare intervals, which amounts practically to the use of none at all. When 5 to 10 loads per acre are used, it is the general practice to apply such quantities every year, although a tendency to apply such amounts every two years is shown. When larger quantities are used, the custom is to make the application once in two years. This is due, undoubtedly, to the habit of apple trees to bear normally every other year, and the manure is applied the year before the crop is expected. In general, 5 to 10 loads per acre are applied every year or larger amounts every other year.

TABLE 27. CORRELATION OF QUANTITY AND FREQUENCY OF APPLICATION OF STABLE MANURE

Quantity per acre	Frequency of application				Total no. of orchards
	Every year	Every 2 years	Every 3 years	Occasionally	
Less than 5 loads	5	4	....	30	39
5–10 loads	34	26	6	10	76
10–15 loads	23	33	14	8	78
15–20 loads	13	14	8	1	36
20–25 loads	8	11	4	2	25
30 +	2	4	3	1	10
Total	85	92	35	52	264

Relation of quantity and frequency of application to yield and income.— The effect of the quantity and frequency of application of stable manure on yield per acre and income per acre is shown in Table 28. Although the figures in this table are not based on sufficiently large numbers of cases to warrant any very definite conclusions, certain tendencies may be noted. No good results may be expected from the application of less than 5 loads per acre, especially if that is applied only occasionally (less than once in three years), as shown by a four-year average yield of 39 barrels per acre, and an income of $70 per acre. If manure is applied only occasionally, it is better to apply it in large quantities, i. e. 20 loads or more per acre, which shows a yield of 77 barrels and an income of $174.80 per

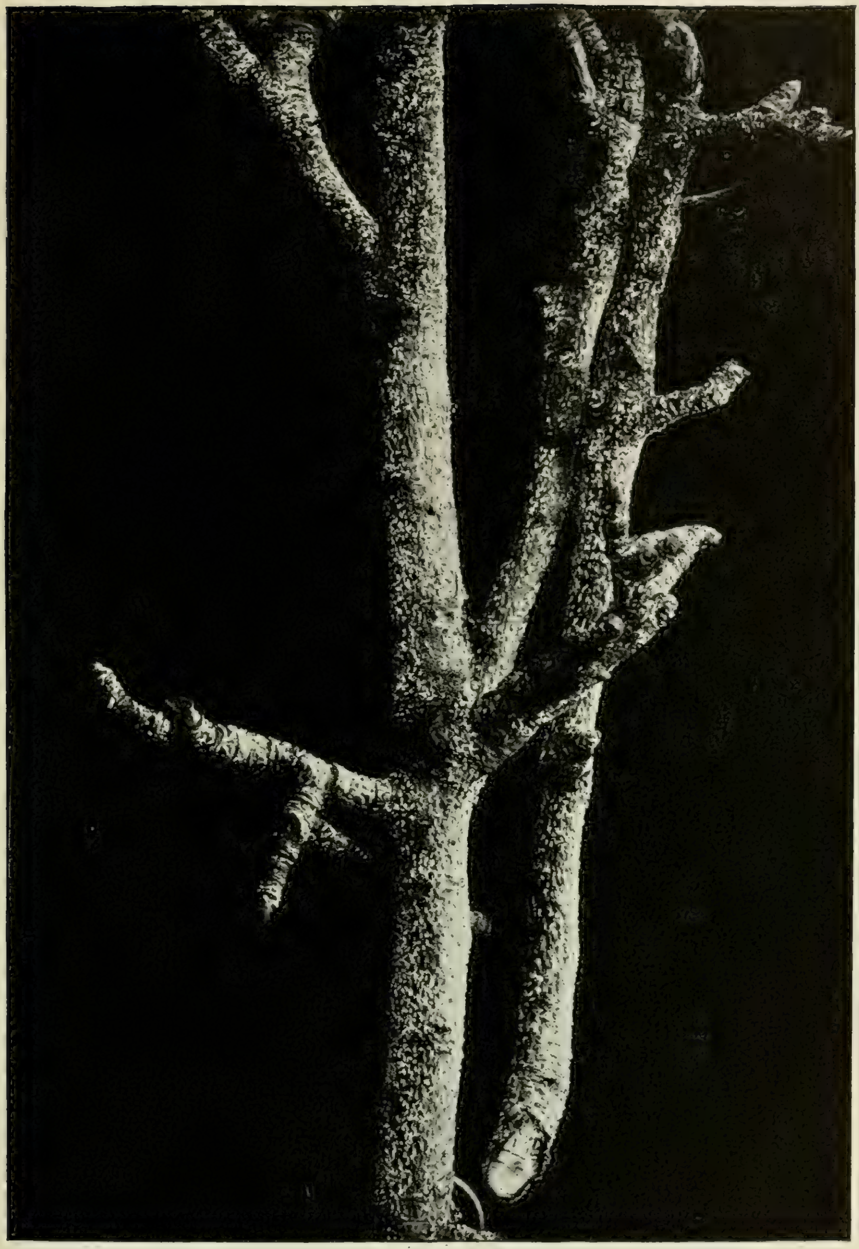

FIG. 22.—*A bad case of scurfy scale. Treatment given in Cornell Bulletin 283*

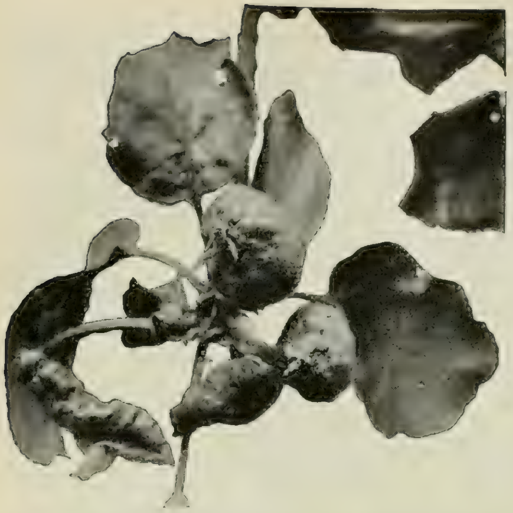

FIG. 23.—*Fruit and foliage injured by aphis. For treatment see Cornell Bulletin 283.*

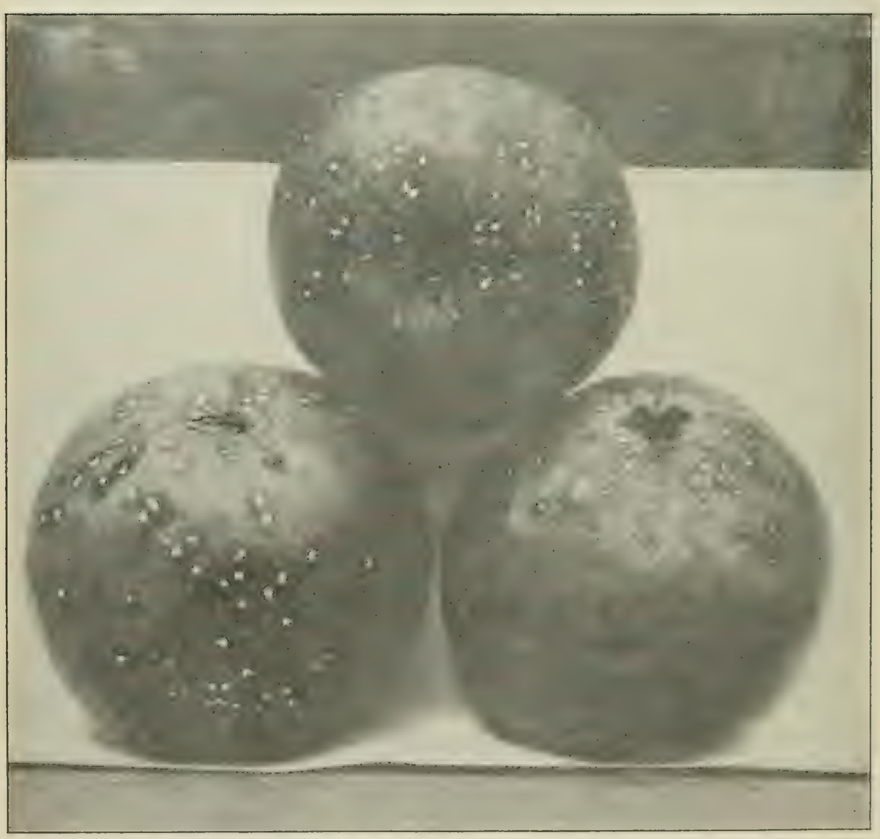

FIG. 24.—*Scurfy scale sometimes disfigures fruit as badly as San Jose scale*

acre. The best amount to apply every year seems to be 10 to 15 loads per acre. This treatment gives a four-year average yield of 83 barrels per acre and an income of $147. Larger amounts applied every year are not so beneficial. Fifteen to twenty loads seems the best amount to apply once in two years, for although the yield appears larger for smaller amounts, the income per acre increases with the amount of manure applied, being $124.23 for 5 to 10 loads, $127.28 for 10 to 15 loads, and $147.12 for 15 to 20 loads.

TABLE 28. EFFECT OF QUANTITY AND FREQUENCY OF APPLICATION OF STABLE MANURE UPON YIELD AND INCOME

Quantity per acre	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
			1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
Less than 5 loads:												
Occasionally	10	46.5	59.5	28.0	49.7	20.5	39.4	$84 20	$41 85	$99 00	$56 10	$70 29
Every year	2	9.0	60.0	49.4	71.9	30.0	52.8	85 54	115 00	143 78	87 08	107 85
Once in 2 years	2	26.0	45.6	40.0	49.0	21.1	38.9	85 29	108 61	76 01	63 46	83 34
5–10 loads:												
Occasionally	4	17.0	96.0	65.2	53.9	46.4	65.4	102 94	146 30	100 59	150 53	125 09
Every year	10	70.5	77.2	54.2	64.5	14.3	52.6	133 08	135 77	124 14	37 60	107 65
Once in 2 years	5	17.0	92.2	71.1	120.3	29.0	78.2	123 47	121 91	208 60	42 94	124 23
Once in 3 years	3	22.0	93.2	54.9	40.9	37.6	56.7	150 00	158 33	187 50	279 17	193 75
10–15 loads:												
Occasionally	7	42.0	37.1	41.9	42 7	38.9	40.2	47 27	90 48	75 24	95 15	77 04
Every year	10	62.0	131.6	61.7	90.6	48.1	83.0	172 18	120 21	163 85	131 06	146 82
Once in 2 years	11	67.8	93.0	84.8	57.7	45.5	70.3	129 95	151 88	97 28	130 03	127 28
Once in 3 years	4	20.0	81.3	50.8	69.5	40.0	60.5	107 50	85 81	136 80	113 96	111 02
15–20 loads:												
Every year	5	38.5	96.0	39.0	59.5	32.1	56.6	145 88	78 65	119 50	76 73	105 19
Once in 2 years	4	28.5	89 1	91.7	54.8	45.6	70 3	163 16	182 37	110 66	132 31	147 12
Once in 3 years	3	12.5	141.5	50.8	58.8	34.8	71.5	179 91	75 86	134 76	99 52	122 50
20–30 loads:												
Occasionally	2	16.5	103.0	84.8	80.9	39.4	77 0	175 15	217 61	175 43	131 03	174 80
Every year	3	24.1	48.5	58.5	53.4	32.5	48.2	75 52	109 54	108 17	103 04	99 07
30 + loads:												
Every year	1	2.5	50.0	60.0	56.0	21.6	46.0	80 00	141 00	112 00	60 50	98 37
Once in 3 years	1	3.0	54.0	50.0	33.3	6.6	36.0	81 00	92 50	75 00	20 00	67 12

ORCHARD PESTS AND DISEASES

Ontario county seems to have its full share of orchard enemies. Table 29 gives 15 of those reported, with the number of orchards in which they occur. The blister mite appears to have been the most troublesome at the time this survey was made, having been reported as occurring in 305 orchards. Among the chewing insects, the codling moth, tussock moth, pistol and cigar case bearers, bucculatrix, tent caterpillar, and curculio were and probably are most prevalent. Of these the codling moth is the most injurious, with the tussock moth a close second. The following insects were reported in a few orchards: army worm, cankerworm, fall webworm, bud moth, leaf miner, borer, and tree hopper.

Among the sucking insects, after the blister mite, the oyster shell scale is reported most frequently, occurring in 202 orchards. Scurfy scale, San José scale and aphis also occur to some extent.

The chief fungus troubles are canker, occurring in 245 orchards, twig blight in 137, scab in 82, and collar rot in 88.

It is probable that the number of orchards in which the above pests are found gives only a very rough estimate, for no doubt many may have occurred in orchards for which they were not reported.

TABLE 29. ORCHARD PESTS

Name	No. of orchards
Chewing insects:	
Codling moth	133
Tussock moth	129
Case bearers	117
Bucculatrix	32
Tent caterpillar	16
Curculio	12
Sucking insects:	
Blister mite	305
Oyster-shell scale	202
Scurfy scale	30
San José scale	24
Aphis	29
Plant diseases:	
Canker	245
Twig blight	137
Scab	82
Collar rot	88

SPRAYING

General practice

From the abundance of orchard troubles, it is clearly evident that to produce the best fruit a much more thorough and intelligent spraying campaign must be carried out. Thirty-four per cent of the orchards are unsprayed (Table 30). When we consider that orchards sprayed once are little better than those sprayed not at all, over half the orchards are practically unsprayed.

TABLE 30. SUMMARY OF ORCHARDS SPRAYED AND UNSPRAYED

No. of applications	No. of orchards	Per cent
One	67	18.2
Two	117	31.7
Three	54	14.6
Four	5	1.4
Total sprayed	243	65.9
None	126	34.1

The chief spray mixture is bordeaux, a spray intended to combat fungous diseases. Less than a third of the orchards are reported as using mixtures containing arsenical poisons intended for chewing insects.* Yet Table 29 shows that these insects are very prevalent. Only 23 orchards are reported as using sprays, such as lime and sulfur, scalecide, and kerosene emulsion, that are inimical to sucking insects. This, no doubt, accounts for the large number of orchards infested with oyster shell scale.

Bordeaux mixture is applied chiefly in the proportion 3–3–50, although 4–4–50 and 4–6–50 are used to a considerable extent. Some of the other proportions used are stated in Table 32.

The reports concerning the effect of spraying show good results in 80 per cent of the orchards, while only 15 per cent report injury. The hand pump seems to be the favorite type of sprayer, being used in 134 orchards. Power sprayers are used in 34 orchards.

TABLE 31. SUMMARY OF SPRAYING CONDITIONS AND PRACTICES

No. of applications	Bordeaux	Arsenical compounds	Lime and sulfur	Scalecide	Kerosene emulsion
One	58	30	15	5	1
Two	106	55	1	1	....
Three	54	31	....	....	....
Four	4	4	....	....	....
Occasional	3	....	....	....	....
Miscellaneous	5	....	....	....	....
Total	230	120	16	6	1

---

* It is interesting to note that the orchards sprayed four times with bordeaux were sprayed also with arsenical poisons.

General results of spraying	No. of orchards
Effect.	
Excellent	4
Good	96
Fair	6
Injury	18
Machinery	
Hand pumps	134
Power pumps	34

TABLE 32. BORDEAUX FORMULAE IN USE

	No. of orchards
3-3-50	44
3-4-50	5
3-5-50	6
4-4-50	18
4-6-50	20
5-5-50	13
6-6-50	8

Relation of spraying to yield and income

Table 33 shows that it pays to spray. Orchards not sprayed at all produce a very low yield, 40.2 barrels per acre on the average for four years, with an income of $67.66. The group of orchards sprayed once yield a little more, having a four-year average yield of 50.6 barrels per acre, and an income of $83.40. For orchards sprayed twice, the four-year average yield is about 63 barrels per acre and the income about $116. The group of orchards sprayed three times, although yielding little more on the average for four years than those sprayed twice, surpass all others in income, which is $140.26. The number of orchards sprayed four times is hardly large enough to warrant any definite conclusions, but it is interesting to note that they produce the heaviest yield, on the average, although the income is lower than that of orchards sprayed three times.

The significant fact in Table 33 is that both the unsprayed orchards and those sprayed once are far below the general average in both yield and income; those sprayed two times or more are well above the general average. It is better to spray once than not at all, but to get results worth while two or more applications must be made. The best results were obtained in orchards sprayed three times.

TABLE 33. RELATION OF SPRAYING TO YIELD AND INCOME

No. of applications	No. of orchards	Acres	Yield per acre (bbls.)					Income per acre				
			1904	1905	1906	1907	4-yr. av.	1904	1905	1906	1907	4-yr. av.
None	33	158.8	60.8	35.2	42.5	22.1	**40.2**	$77 74	$61 21	$80 73	$50 96	**$67 66**
One	26	241.0	71.6	45.9	51.7	33.1	**50.6**	89 08	93 02	63 55	87 96	**83 40**
Two	61	376.3	87.9	59.0	67.9	37.7	**63.1**	120 00	123 29	122 73	99 17	**116 30**
Three	35	280.6	76.6	67.2	65.8	47.8	**64.3**	126 58	145 51	140 63	148 32	**140 26**
Four	4	41.0	84.7	80.6	83.1	40.4	**72.2**	84 21	197 81	115 64	97 10	**123 69**

SUMMARY OF THE SURVEY

Geographical distribution.— Eighty-nine per cent of the orchards are in the eastern half of the county and are concentrated mainly in the southeastern part around Seneca Castle, Geneva, Stanley, and Halls Corners.

General average yield and income.— The four-year average yield per acre for all orchards of Group I is 58.4 barrels; the four-year average income is $111.51.

Distribution of orchards according to yield and income.— The typical four-year average yield per acre is between 40 and 60 barrels; the majority of the orchards produce less than 60 barrels. The typical income per acre is between $80 and $120. About 55 per cent of the orchards are below $120.

Size of orchards.— The typical size of apple orchards in Ontario county is two acres, although the median is five acres, and the mean size between seven and eight acres.

The smaller orchards as a rule give better results than the larger orchards. Orchards of three acres or less yield on the average about 66 barrels per acre, with an income of $123; orchards of twenty acres or more yield less than 50 barrels per acre, with an income of $106.32.

Condition of orchards.— Five per cent of the orchards are reported in very good condition, 40 per cent in good condition, while over half the orchards are either fair or poor.

The four-year average yield per acre of the poor orchards is 48 barrels, with an income of $81; the very good orchards produce 77 barrels per acre on the average and an income of $172; those in good condition produce 65 barrels, with an income of $126.

Aspect.— Over 45 per cent of the orchards slope toward the east, about 18 per cent slope toward the west, while 7.3 per cent are level.

The orchards that are level have the highest yield, 68 barrels per acre, with an income of $133. Those sloping to the west are the lowest in the scale.

Elevation.— The elevation of the orchards of Ontario county varies from 500 to 1100 feet. Most of the orchards are between 800 and 900 feet in elevation.

There is apparently no relation between elevation and yield or income for the orchards studied.

Age of trees.— Orchards between 30 and 34 years of age are most frequently met in Ontario county. Seventy-nine per cent of the orchards are 30 years old or more, and 14 per cent are 50 years old or more. Orchards of young trees are comparatively few.

The greatest yield per acre is produced by the orchards between 25 and 29 years old, and by those between 50 and 59 years old, both groups producing practically 65 barrels per acre. The largest income is produced by orchards between 40 and 44 years old.

Varieties.— The chief commercial varieties planted in the county are Baldwin, Rhode Island, Northern Spy, Tompkins King, and Roxbury.

Planting plan.— Practically all of the orchards are planted either on the square or rectangular plan. The typical distance is 33 x 33 feet.

Pruning.— The general practice is to prune every year, yet the general character of the pruning is only fair. Less than 24 per cent of the orchards are well pruned. The chief method of pruning is to thin out the trees a little.

Soil types.— The chief soil types are the gravelly and sandy loams, which produce the highest yields and incomes. The highest yield, 63 barrels, is produced on sandy loam.

Drainage.— Sixty-four per cent of the orchards are either wholly or partly tile-drained, yet only 49 per cent are reported as having good drainage. Natural drainage produces the highest yield and income (67 barrels per acre being the four-year average yield, and the income $121). The essential point, however, is that the drainage, whether natural, artificial, or both, must be good; otherwise the orchards are below the average.

Soil management.— Orchards in sod are the general rule. Fourteen per cent have been tilled 5 years or more.

The highest yield and income are produced by orchards tilled 5 years or more; the yield for such orchards is 61 barrels, and the income $133 on the average for four years.

Management of sod orchards.— As a rule, sod orchards are not pastured. In orchards which are pastured, hogs are the chief animals used, although sheep are pastured to a considerable extent.

Sod orchards pastured with hogs and sheep yield the highest returns. Such orchards have a four-year average yield of 63 barrels per acre, with an income of $122. In general, hogs seem a little more valuable in pasturing orchards than sheep. Cattle and horses are destructive.

Fertilizers.— The chief fertilizer used is stable manure, which is used by 76 per cent of the growers, either alone or in combination with commercial fertilizer, green manure, or both. Commercial fertilizers and cover crops are not very generally used.

Orchards that are not fertilized have a four-year average yield of 44 barrels per acre and an income of $71.54. The highest average income occurs for orchards treated with stable manure and commercial fertilizer, being $125.95.

Stable manure applied at the rate of 10 to 15 loads per acre every year, or 15 to 20 loads every other year results in high yields, and incomes of about $147 per acre.

Orchard pests and diseases.— The chief orchard pest reported is the blister mite, which was found in 305 orchards. The codling moth and tussock moth are the chief chewing insects reported. Of plant diseases, canker and twig blight are most troublesome.

Spraying.— Thirty-four per cent of the orchards are actually unsprayed, and over half the orchards are essentially unsprayed.

Bordeaux is the chief spray mixture used. Less than a third of the orchardists are reported as using arsenical poisons. Only about 6 per cent are using sprays such as lime and sulfur to combat sucking or scale insects.

Unsprayed orchards yield 40.2 barrels per acre on the average for four years, with an income of $67.66. The orchards sprayed once are not much higher in yield and income. The highest income is produced by the orchards sprayed three times, which have an average income of $140.26.

APPENDIX

PART I

Tables 34, 35, and 36 show yields and incomes for orchards of Group III (all orchards of 1907 and 1908), together with the two-year means (1907 and 1908) and five-year means (1904-1908) for methods of soil treatment, use of fertilizers, and spraying. These tables are inserted as a matter of record. Deductions from them should be made cautiously, since the figures for yield and income are not always for the same orchards.

TABLE 34. SOIL TREATMENT, 1907 AND 1908

Method	1907			1908			2-yr. av.	5-yr. av.
	No. of orchards	Acres	Yield per acre (bbls.)	No. of orchards	Acres	Yield per acre (bbls.)	Yield per acre (bbls.)	Yield per acre (bbls.)
Tilled 10 years	27	201	43.5	11	111.5	94	61.5	59.5
Tilled 5–10 years	13	133	33.6	12	97	84	55.0	66.0
Tilled 3–5 years	37	251	34.0	26	199	47	40.5	54.0
Sod 3–5 years	60	371	35.5	37	174	80	50.0	56.0
Sod 5–10 years	54	318	31.2	31	207	60	42.5	58.0
Sod 10 years or more	127	725	29.5	75	466	66	44.0	53.5
			Income per acre			Income per acre	Income per acre	Income per acre
Tilled 10 years	27	226	$141 50	10	61.5	$119 00	$128 00	$123 00
Tilled 5–10 years	16	144	92 00	12	97	152 00	117 00	130 00
Tilled 3–5 years	33	253	86 50	27	204	87 00	87 00	98 00
Sod 3–5 years	63	387	86 00	38	178	148 00	102 00	105 00
Sod 5–10 years	46	283	78 00	31	207	105 00	90 00	108 50
Sod 10 years or more	106	640	80 00	74	459	106 00	92 00	95 00

TABLE 35. RELATION OF USE OF FERTILIZER TO YIELD AND INCOME, 1907 AND 1908

Fertilizer	1907			1908			2-yr. av.	5-yr. av.
	No. of orchards	Acres	Yield per acre (bbls.)	No. of orchards	Acres	Yield per acre (bbls.)	Yield per acre (bbls.)	Yield per acre (bbls.)
None	44	270	19.0	34	209	59.0	36.5	36.5
Stable manure	169	973	32.5	89	581	64.0	44.5	57.0
Stable manure and commercial fertilizer	30	311	44.0	20	232	76.0	53.0	54.6
Stable manure and cover crop	33	212	45.0	18	114	68.2	57.2	59.6
			Income per acre			Income per acre	Income per acre	Income per acre
None	48	234	$44 00	36	217	$84 00	$63 50	$59 20
Stable manure	160	956	88 00	89	577.6	110 00	96 00	106 80
Stable manure and commercial fertilizer	26	284	123 00	20	187.5	102 00	110 00	108 50
Stable manure and cover crop	32	220	121 00	18	114	89 00	113 00	117 00

TABLE 36. Relation of Spraying to Yield and Income, 1907 and 1908

Applications	1907			1908			2-yr. av.	5-yr. av.
	No. of orchards	Acres	Yield per acre (bbls.)	No. of orchards	Acres	Yield per acre (bbls.)	**Yield per acre (bbls.)**	**Yield per acre (bbls.)**
None	69	339	23.5	51	323	62.4	**40.5**	**42 5**
One	53	379	31.0	31	215	61.0	**41.8**	**50.0**
Two	104	661	33.0	63	417	73.0	**49.0**	**60.0**
Three	59	452	44.0	34	267	49.7	**46.4**	**59.0**
Four	4	41	40.4	4	41	74.0	**57.0**	**69.2**
			Income per acre			Income per acre	**Income per acre**	**Income per acre**
None	77	433.5	$46 60	52	327	$90 00	**$65 40**	**$68 70**
One	53	382	89 90	30	211	89 90	**89 90**	**86 00**
Two	96	608	89 70	64	421	121 08	**101 00**	**123 00**
Three	56	458	114 00	34	267	98 00	**108 00**	**124 00**
Four	4	41	97 10	4	41	155 80	**126 50**	**123 69**

APPENDIX

PART II

STATISTICAL METHODS AS APPLIED TO ORCHARD SURVEYS

GENERAL THEORETICAL CONSIDERATIONS

The use of statistical methods in the study of horticultural problems, as well as in the problems of the larger fields of agriculture and biology, is increasing rapidly. Prof. Karl Pearson says, "Criticism demands now quantitative exactness." Theories are not valuable until they are backed up by experience, and experience is summed up by statistics. By constantly widening the scope and increasing the numbers of cases upon which figures are based, old principles may be corroborated or corrected, new principles may be deduced, and the theory of orchard management may have a practical foundation.

THE PRINCIPLES UNDERLYING STATISTICS

In order that one may study the figures in statistical tables more intelligently, he must understand the basic principles of statistics and the methods by which statistical results are obtained.

Law of probability and normal distribution

Whatever chance value an individual may have, a large number of individuals, when classified according to their increasing values, are found to distribute themselves more or less regularly. A few will be found at the lowest value, increasing numbers at the higher values, until the maximum frequency is reached. From this point until the highest value in the range of distribution is reached the frequency decreases. It makes little difference whether the individuals composing the group, or *population* as it is called, are orchards, poppies, human beings, or what not; or whether the classes are different types of orchard management, stigmatic bands, or heights; or whether the values are measured in terms of barrels, dollars, integers, or inches; the great mass of the individuals lies very close to a central value, with about equal numbers above and below it. Only a few individuals are found at the extremes. Because of chance accidents, each individual differs from the central value, but the law of probability of error is that the algebraic sum of the positive and negative deviations is zero. It is this normal distribution of a population about a central point that underlies all statistical work. We can sum up very briefly, therefore, the facts contained in a great mass of material by stating the value of the central point or average.

Averages

The average value which symbolizes the individuals of a population may be determined in different ways, three of which will be discussed briefly.

Mode.— The value or measure which occurs most frequently is called the *mode*. The true mode is the highest point of the theoretical frequency curve, but the mode ordinarily used is the maximum observed frequency, called empirical mode. It is this latter value that is used as mode in the present survey.

Median.— If all the individuals in the population were arranged in order of their increasing values, the value of the individual in the middle of the group would be the *median*. The importance of this average lies in the fact that half the individuals lie above the median and half below; the chances are even, therefore, that any previously unknown measure may exceed or fall short of the median.

Mean.— The average most commonly used is the arithmetical mean, ordinarily called simply the *mean*, without a limiting adjective. This is determined by adding the values of the individuals and dividing the sum by the total population. Such a mean is considered the best rule for determining the most probable measure in a group of observed cases, because the algebraic sum of the positive and negative deviations of the observed values from the mean is zero. It is this mean that has been used in the tables of the present survey.

In a normal distribution in which the individuals arrange themselves symmetrically about the mean, as is shown graphically by the normal curve, these different values (mode, median, and mean) approximate each other very closely, and any of them may be used to describe the population. In many cases, however, the curve of the distribution is not symmetrical, but is what Professor Pearson calls a *skew curve*, in which case the mode may deviate widely from the mean.

Measure of variability

Standard deviation.— An average in itself will not give an adequate description of the population. The individuals deviate from the mean, some above it and some below it; some lie very close to the mean, others deviate widely from it. It is desirable to measure this variability and the degree of concentration about the mean. Such a measure is found in the *standard deviation*, which is determined by the method of least squares. If the standard deviation is small, the mean may be taken as representing closely the values of the general run of the population. On the other hand, if the standard deviation is large there is wide variation from the mean, which shows either that the individuals of the sample chosen are not fairly representative of the population, or are so variable that the mean has little importance.

Coefficient of variation.— The mean and standard deviation describe the absolute values of individuals of one group. But in order to compare the values of one group with another, it is necessary to have a measure of relative variability. Such a measure is found by dividing the standard deviation by the mean; the result is called the *coefficient of variation.*

Comparison by percentages

Percentage frequency.— A simple frequency distribution, or frequency curve, describes the absolute values of the individuals of the group for which it is made. But if the frequency of the observed cases is reduced to percentages, a means is given at once for comparing the values of one group with another.

Percentage distribution.— A scheme of distribution enables one to see the proportion of individuals of the entire group that is measured by any value or lies between two values. Such a scheme may be represented graphically as in Plate II, or by a single line or column of figures, as in Table 2. When such a scheme of distribution is made for a sufficiently large number of cases, it is useful for determining the rank of any single individual of the population. By looking for the grade of the individual under consideration, we may see what percentage of the population lies above it and what percentage lies below it. If comparison is made from year to year, the individual gain or loss may be determined. Schemes of distribution for different groups offer a good basis for comparison of different populations.

THE ORCHARD SURVEY FROM THE STATISTICAL STANDPOINT

The value of an orchard survey.— In making an orchard survey we are trying to determine the value of various types of orchard practice. Each orchard, therefore, might be considered an experiment plot in which the different methods of orchard management are the experiments. To be sure, the work may not be conducted so scientifically as at an experiment station; but the fact that there are many experiments along the same lines and extending over a great territory counterbalances the scientific precision of a few more or less artificial experiments. When large numbers of orchards are considered, the law of chance operates to overcome the local variations of individual orchards.

Value of results.— The value of results in survey statistics depends upon:
1st, the accuracy of the field data;
2d, the number of observations;

3d, the variability of individuals within the group;
4th, mathematical accuracy in tabulation.

Accuracy of data.— One must not expect absolute scientific accuracy in the figures of an orchard survey, for the following reasons: The data are collected under varying conditions. Personal opinion plays an important rôle. One's judgment concerning conditions varies from time to time. Many figures are doubtless an approximation. On the other hand, many of the figures for yield and income recorded in the survey were taken directly from the growers' books. These are of more value than the approximations, and might therefore have been weighted. None of the figures in the survey, however, have been weighted technically. In spite of the chances for inaccuracy in the field reports, the law of probability of error is such that if the number of reports is sufficiently large, the sum of the positive errors equals the sum of the negative errors and the average will be reliable.

Number of observations.— The weight to be given a series of observations is proportional to the square root of the series. A series of 400 observations should carry twice as much weight as a series of 100 observations. The numbers in the present survey are in many cases too small to be of much value statistically. In all cases the average given would be of greater value if based on far larger numbers, yet they form an interesting indication of the probability of similar results being obtained under similar conditions.

Variability of individuals within the group.— The number of cases necessary to give weight to the result depends also upon the variability of the individuals within the group. If the standard deviation is small, there is little variation in the individuals. A much smaller sample, in this instance, would represent the total population than in cases of great variability. If the standard deviation is large, we should not expect to find the mass of the individuals near the mean.

Mathematical accuracy in tabulation.— Not only is it necessary that the field data should be as accurate as possible, but these figures must be tabulated with mathematical accuracy. In tabulating the data, no effort has been spared to make the lists accurate. In all cases the observed totals as reported in the survey sheets were used in determining the average yield and income per acre. When the yield was reported in bushels the number was changed to the equivalent in barrels by dividing it by 3. In order that there should be no errors in addition, the lists for determining the means were added on a Burroughs adding machine and carefully checked. The averages in the tables based on the orchards of Group I, in nearly all cases, were determined both by slide rule and by the ordinary method, one serving as a check to the other. The averages for the tables of Group III were read directly from the slide rule, for the data in this group are so heterogeneous and the totals so large that this method is considered sufficiently accurate.

Comparative value of different tables.— The tables of Group I are considered of more value than the others for purposes of comparative study, since the averages for the different years are determined from reports of the same orchards for each year, and both yield and income are based on the same orchards. The relation of yield to income and the variations from year to year may be deduced, therefore, with some degree of accuracy. On the other hand, in the tables of Group III for 1907 and 1908, together with the two-year and five-year means into which those figures enter, comparison of yield and income for the same point should be made cautiously, since in many cases the figures for yield and income are not based upon the same orchards. This holds true for 1907 far more often than for 1908.

The value of the income per acre as a measure in orchard statistics.— The value of interpreting results by means of the average income per acre is seen again and again in the present survey. In many cases, if conclusions were drawn merely from the mean yield per acre, they would be misleading. There is often an unusually heavy yield of inferior apples. If the type of orchard management were judged in this case by yield only, error would be made. For instance, the yield per acre for orchards in sod 5–10 years as shown in Table 22 is 63.2 barrels, which is considerably above the general average, 58.4 barrels. Yet the income for the same orchards is only $104, as compared with the general average $111.51. The yield per acre for orchards tilled 10 years or more is 56 barrels, which is below the general average. The income per acre for the same orchards is $128.68, an amount very much above the general average. If the yield alone were considered in these instances, one would conclude that sod treatment of orchards was more profitable than cultivation. A consideration of the money value of the crop, however, shows this idea to be erroneous.

It is the habit for most varieties of apples to bear a heavy crop normally every other year. This fluctuation in yield per acre is shown in Table 1, in which it is seen that 1904, 1906, and 1908 were years of heavy yield, whereas 1905 and 1907 were years of light yield. The incomes, on the other hand, show much less fluctuation. Of the two means, yield and income, the income would seem the better criterion since it is a steadier value. This follows also from Table 2 and the curves of percentage of frequency and distribution. There is much less difference between the mode and the mean in income per acre than in yield per acre.

Value of the general average of the group.— In comparing the yields and incomes of the different classes in the same table, it is not enough to consider merely the figures of the table. In many cases, the absolute value of one class may be above another, yet if both are below the general average of the population neither should be considered of especial merit, for a desirable practice is one that produces a yield and income above the general average.

The general average is of value, also, in determining whether or not there is any relation between the condition or practice and the yield and income. When we find that in classes large enough to be considered statistically the yields and incomes of the different classes not only are very close to each other but approximate the general average, we may conclude that the condition under discussion has no influence, but that the law of probability is in operation. If, on the other hand, the classes fall into distinct groups, one lying above the general average and one below, it is quite evident that something other than the law of chance is at work. We may conclude safely, then, that the one practice is beneficial and the other injurious.

Shall the orchard or the acre be used as unit?— It has been shown that there are various ways of determining an average. In orchard surveys a further difficulty may be encountered, namely, the question of the units whose values are to be averaged. If we consider the orchard as a unit representing a certain set of conditions, the effect of various types of orchard management is better shown by a yield per acre per orchard. The conditions in each orchard, moreover, are determined largely by the man who is working the orchard; and the figures for all the acres of the orchards are the estimate of this one individual. By taking the orchard as unit, therefore, we may not only determine an average representative of the condition of the orchards, but may deal with the farmer who is responsible for the condition. The orchard represents the man for whom these results are being determined; the acre, in itself, represents so much land that may be used well or ill. It does not express the conditions in the orchard but is used as a measure of the size of the orchard. When the acre is used as unit, the mean is weighted, as far as the orchard is concerned, and the size overwhelms the results. This weighting is purely relative, for the mean obtained by using the acre as unit is a correct mean for the district which those acres represent. But such a mean does not give, necessarily, a correct idea of the results of the conditions of the orchards in that district. On the other hand, the mean obtained by using the orchards as unit would not give a correct idea of the mean per acre. If a knowledge of the total amounts raised or the value of the crops is paramount, the acre is the only unit to be used.

The question, therefore, whether the acre or the orchard is to be used as unit, resolves itself into a question of the purpose of an orchard survey. If it is to obtain a census of the existing conditions of the industry, the yield and income per acre should be used. The theoretical value of different methods of orchard management, however, may be better expressed by using the orchard as unit.

The amount of difference in the yield per acre and the mean yield per acre per orchard depends on the uniformity in the size of orchards. In cases in which the size of orchards is fairly uniform, the difference between the two means is negligible. When some of the orchards are large and some small, the influence of the size of the orchard is shown in the mean.

Value of standard deviation and coefficient of variation in orchard surveys.—Further research in orchard surveys would be of value in establishing the degree of risk and the probability of the mean values being reached under various types of orchard management and for various kinds of fruits. Such figures would be of value from the standpoint of investment, both for those who have already invested and for prospective orchardists. For such purposes the standard deviation is of value. It is a measure of the absolute variability of yields and incomes of the orchards of the group for which it was determined, and shows, also, the concentration of the values about the mean. In this way, the probability of the mean value and deviations from the mean are indicated. A deviation of one half the standard occurs with a frequency of 61.7 per cent of the cases; a deviation greater than the standard in 31.7 per cent; a deviation of twice the standard occurs in comparatively few cases; and one of three times the standard is very rarely found.

When it comes to a question of the comparative value of the different types of orchard management, or of different fruits, the coefficient of variation is of value. Such a measure of relative variability would answer the question concerning the comparative profit in raising peaches or apples.

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THE COLLEGE OF AGRICULTURE
Department of Entomology

THE PLUM LEAF-MINER

By C. R. CROSBY

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THE PLUM LEAF-MINER

Nepticula slingerlandella Kearfott

Order, *Lepidoptera* Family, *Tineidae*

C. R. CROSBY

This bulletin treats of a new insect enemy of the plum and prune. The late Professor M. V. Slingerland first took up the study of the plum leaf-miner in October, 1907, and continued the work with the assistance of the writer during the following year. In February, 1909, Professor Slingerland made plans for publishing the results of this work in bulletin form, but illness prevented the preparation of the manuscript; his untimely death occurred a few weeks later. During the past two years the writer has made further observations on the habits and life history of this moth, and has, in cooperation with C. M. Hooker & Sons of Rochester, N. Y., conducted experiments in the control of its ravages. In preparing the following account, full use has been made of Professor Slingerland's careful and extensive notes and most of the illustrations are taken from his photographs. The drawings were made by Miss Anna C. Stryke.

In an address given before the Eastern Meeting of the New York State Fruit Growers' Association at Poughkeepsie, February 10, 1909, Professor Slingerland gave a brief account of the plum leaf-miner, which was published in the Proceedings of that Association for 1909, p. 122.

NATURE OF THE INJURY

The plum leaf-miner in its injurious stage is a smooth, greenish white larva, one sixth inch or less in length, found during late June and early July feeding between the outer layers of the leaf. Hatching from an egg attached to the under surface of the leaf, the larva penetrates the tissue and first eats a narrow linear mine an inch or less in length, then widens the mine so as to produce an irregular, more or less ovate blotch about one half inch long. The part of the leaf so injured turns brownish and dies. From three to twelve mines are often found in a single leaf. The trees become partially defoliated and the fruit may fall prematurely. When continued for a series of years this injury tends to weaken the vitality of the tree and to injure the size and quality of the crop. Fig. 25 shows a French Damson plum tree badly defoliated in the top. This photograph was taken September 24, when uninfested trees were still in full foliage.

HISTORY AND FOOD PLANTS

The plum leaf-miner is a new fruit pest and is doubtless a native American insect. Injury caused by this insect was first reported to Professor Slingerland in the fall of 1907 by C. M. Hooker & Sons of Rochester, N. Y., who stated that the leaf-miner had been present in their orchard for a number of years and had been gradually increasing in numbers. Mr. J. H. Stewart of Pittsford, N. Y., states that his father's extensive prune orchard, situated about five miles from the Hooker orchard, has been partially defoliated for the past three or four years, apparently by this insect.

That it may occasionally attack apple is quite probable. While examining some old apple trees in a neglected orchard about a quarter of a mile from the Hooker orchard on July 7, 1911, the writer found that mines very closely resembling those of the plum leaf-miner were abundant in the leaves of the water sprouts growing at the base of several trees. Infested leaves were brought to the Insectary, but the larvæ left the mines while in transit and constructed cocoons indistinguishable from those of the plum leaf-miner. The identity of this apple leaf-miner cannot be settled definitely until the moths are reared next spring.

In the Hooker orchard the plum leaf-miner has shown a decided preference for certain varieties. German and Italian prunes are most severely infested; French and Shropshire Damsons are less subject to attack, although some years ago the former variety was badly infested; Diamond, Bradshaw, Lombard, and Rheinclaude are nearly immune.

LIFE HISTORY

The moth.— The adult of the plum leaf-miner is a small bronzy black moth having an expanse of one seventh to one fifth inch (Figs. 32 and 33). The forewings are crossed by a shining white band on the outer third, and the head bears a conspicuous orange tuft. These moths emerge from cocoons at or near the surface of the ground during the daytime in the latter part of May and in early June. During the day they remain quietly on the bark of the trunk and larger branches, none being found on the leaves. Several hundred moths are often found on a single tree; when disturbed they suddenly take flight and most of them settle on the opposite side of the tree. They gradually decrease in numbers, and about the middle of June they disappear. The technical description of the moth as given by W. D. Kearfott (Jour. N. Y. Ent. Soc. XVI, p. 187, 1908) is as follows:

" *Nepticula slingerlandella* new species.

" Expanse 3.5 to 5 mm.

"Head and frontal tuft orange, antenna eye-caps and side tufts white; antenna whitish gray; thorax bronzy black; abdomen light gray; legs yellowish white, posterior tarsi finely ringed with black.

"Forewing.—Bronzy black with a shining white fascia at outer third, cilia and hind wings light gray."

The egg.— The act of egg-laying has not been observed, but probably it takes place in the evening or at night, as the moths are rarely seen on the leaves during the day. The eggs are attached to the under surface of the leaf, usually at the forks of the more prominent veins. The egg (Fig. 35) is about 0.3 mm. long by 0.2 mm. wide, oval in outline, flattened where attached to the leaf and dome-shaped in profile. The green of the leaf shows through the transparent eggshell, making it a difficult object to find. The eggs are most easily located by holding a leaf at an angle in the sun so that the light will strike it obliquely, when they will be seen as minute glistening dots. The exact time required for the hatching of the egg has not been determined, but it cannot be far from two weeks. On June 2, 1908, an examination of the orchard showed that a great number of eggs had been laid; on June 9 no eggs had hatched, and on June 18 hatching had just nicely begun.

The larva.— In hatching, the larva eats its way out of the eggshell on the underside next to the leaf, and enters the leaf directly without coming out on the surface. This is a point of great practical importance, as showing the futility of attempting to kill the larvæ with an arsenical spray. When full grown the larva is about one sixth inch in length, greenish white in color with the head light brown; the contents of the alimentary canal show through the semitransparent body wall as a greenish or brownish stripe. The larva is legless and only slightly flattened; the constrictions between the segments are rather deep but obtuse; the surface of the body is smooth and clothed with dense, very short, microscopic hairs interspersed with a few larger ones. (Fig. 36.)

The mine.— After entering the leaf directly from the underside of the egg, the young larva eats out a narrow linear burrow, or mine, an inch or less in length, leaving the outer layers of the leaf intact. This part of the mine usually follows a tortuous course but may be nearly straight. The larva next enlarges its mine into an irregular ovate blotch about one half inch in length. In the linear part of the mine the excrement is left as a blackish streak extending along the center of the burrow; in the blotch mine it forms a broad, irregular band along the center, but does not extend to the tip. The outer leaf layers overlying the mines turn brownish or yellowish; the upper layer seems to be thinner than the lower, and the mines are more conspicuous when viewed from above. There are often ten or a dozen mines in a single leaf. (Figs. 27 and 28.)

The cocoon.— When full grown the larva leaves the mine through a cut in the upper surface of the leaf, falls to the ground, and there constructs a small flattened brownish cocoon in cracks in the soil, under loose stones, or between the base of the tree and the surrounding soil. Where the ground is undisturbed, the cocoons are rarely found more than an inch below the surface. Sod furnishes ideal winter quarters for the cocoons. In Fig. 26 is shown the method of cultivation formerly followed in the Hooker orchard; the space between the rows was thoroughly cultivated, but a strip of sod several feet in width left beneath the trees afforded excellent winter quarters for the cocoons, and was probably an important factor in producing the very heavy infestation of the orchard. The cocoon (Fig. 29) is light brownish in color, broadly oval, and moderately arched; it is about 2½ mm. long by 1½ to 2 mm. wide, and is usually slightly wider at one end. It is surrounded by a thin flange formed by the closely united edges of the two valves of which the cocoon is composed. The cocoons are held in place by a few strands of silk. The time at which the larvæ become mature and construct their cocoons varies considerably with the season. On July 6, 1911, about one half the larvæ had left the mines; on July 21, 1908, and July 19, 1909, a few larvæ were still present in the mines.

The pupa.— After forming the cocoon the larva apparently does not transform at once; a cocoon opened August 4, 1908, contained a larva. The winter, however, is passed in the pupal stage. On October 10, 1911, the writer opened a number of freshly gathered cocoons and found that all the larvæ had transformed to pupæ.

The pupa (Figs. 30, 31, and 34) is about 2 mm. in length, ovate pointed behind, and somewhat flattened. The ventral surface is brownish yellow, the dorsum greenish. The eyes are dark colored and the orange tuft on the head of the moth shows through the pupal skin. On the dorsum of the abdomen there are six transverse interrupted rows of short brownish spines. On each side of the dorsum is a longitudinal row of wart-like protuberances, each bearing a colorless spine. The anterior spines are very short and they gradually increase in length toward the tip of the body. When about to transform to the adult the pupa works itself partly out of the end of the cocoon, probably by the aid of these spines. The empty pupa skin is left protruding from the cocoon.

PARASITES

No parasites were observed infesting the plum leaf-miner until May 11, 1911, when a cocoon was found containing the larva of a Chalcis-fly. The larva (Fig. 37) is 1.4 mm. long, smooth, whitish in color, and rounded at both ends. On June 2, 1911, two adults of the parasite were found

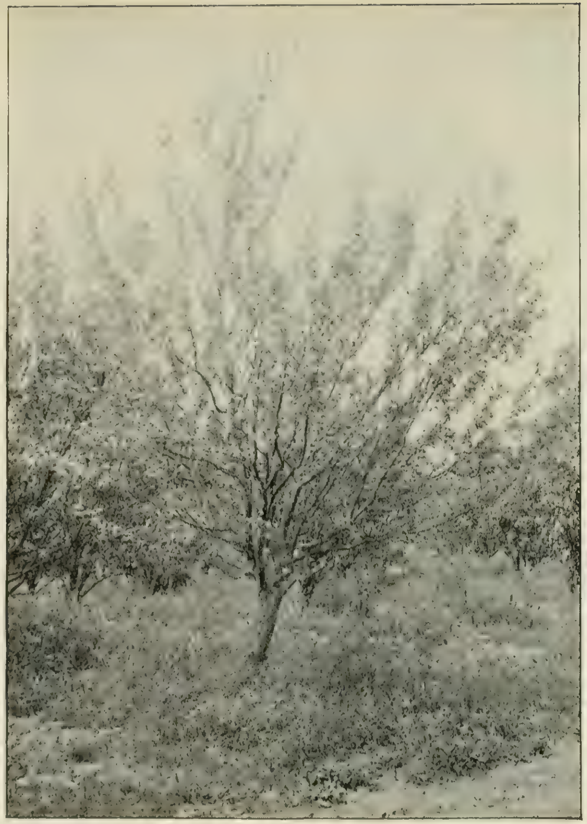

FIG. 25.—*French Damson plum tree partially defoliated by plum leaf-miner*

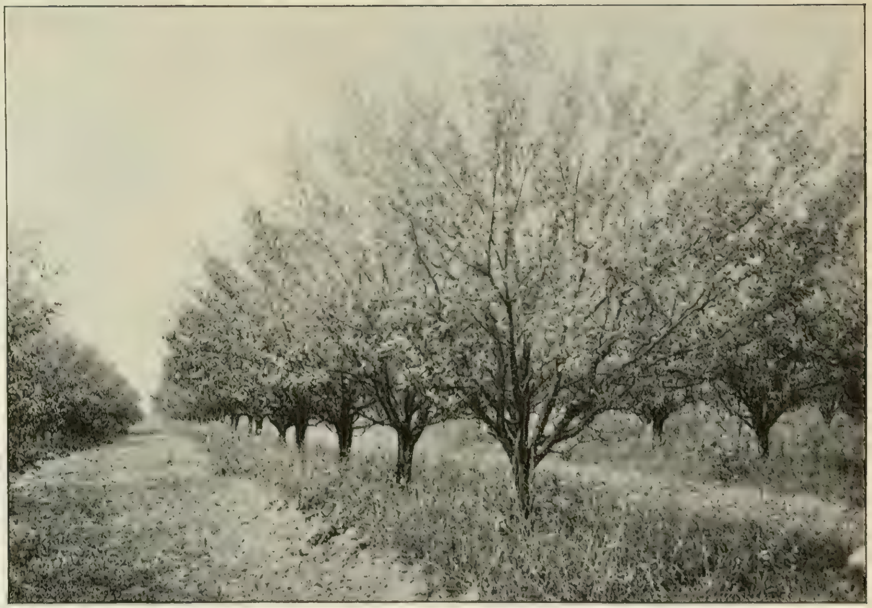

FIG. 26.—*View in Hooker orchard showing strip of sod left beneath the trees in which the cocoons of plum leaf-miner found good winter protection*

PLUM LEAF-MINER

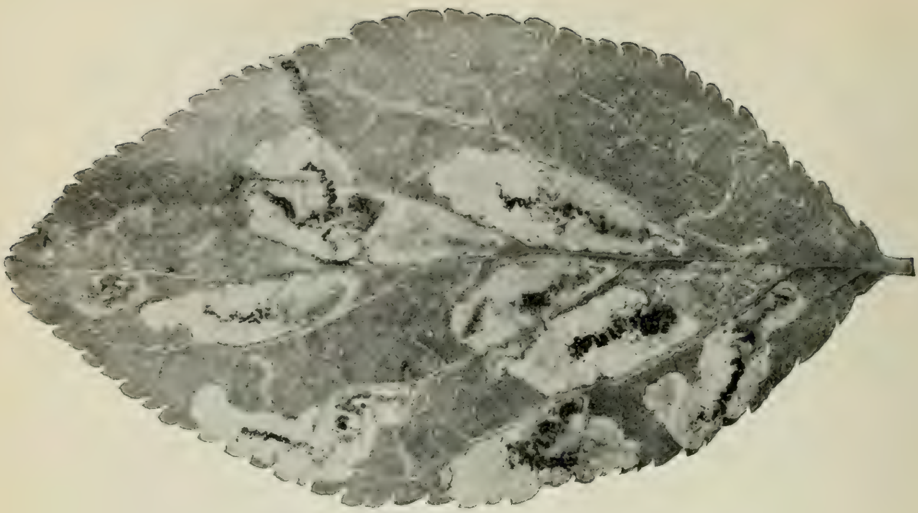

FIG. 27.—*Plum leaf enlarged, showing mines of the plum leaf-miner*

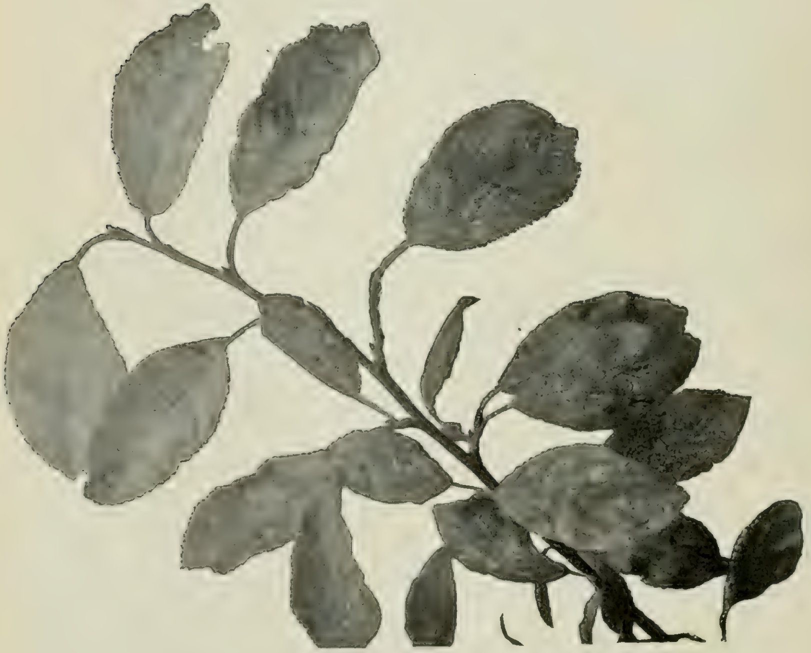

FIG. 28.—*Plum branch showing many infested leaves*

PLUM LEAF-MINER

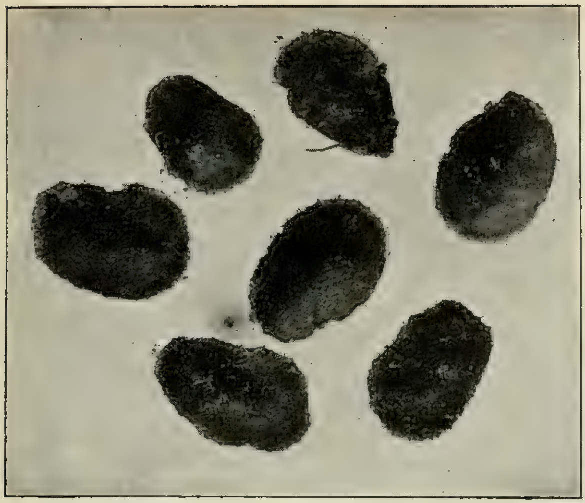

FIG. 29.—*Cocoons*

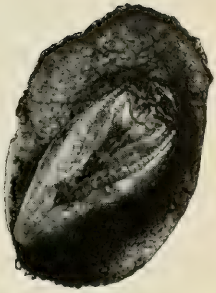

FIG. 30.—*Pupa in cocoon. Half of cocoon removed*

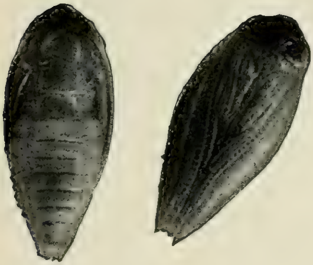

FIG. 31.—*Dorsal and ventral views of pupa*

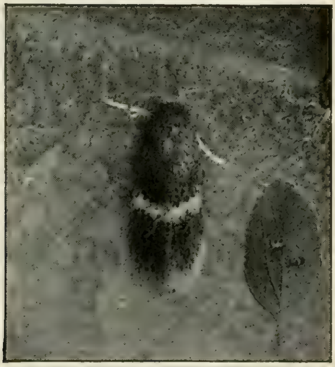

FIG. 32—*Moth at rest on leaf, enlarged; natural size at right*

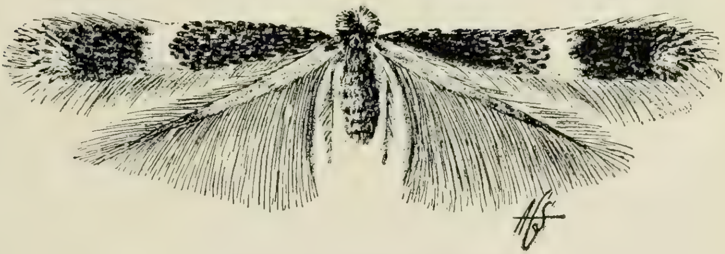

FIG. 33.—*Moth, wings spread*

PLUM LEAF-MINER

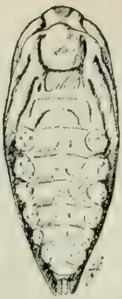

FIG. 34.—*Pupa of plum leaf-miner*

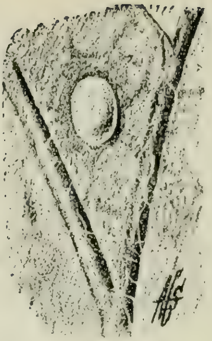

FIG. 35.—*Egg of plum leaf-miner on underside of leaf, greatly enlarged*

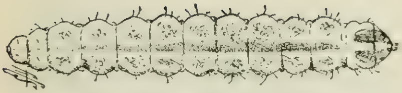

FIG. 36.—*Full-grown larva of plum leaf-miner*

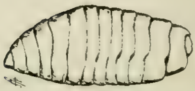

FIG. 37.—*Larva of Derostenus salutaris, parasite of plum leaf-miner*

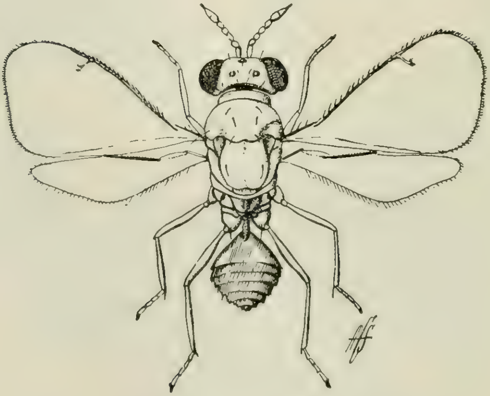

FIG. 38.—*Derostenus salutaris, adult male. Parasite of plum leaf-miner*

PLUM LEAF-MINER AND ITS PARASITE

in a vial containing cocoons of the moth. They had emerged through a smooth round hole in the side of the cocoon. In the fall of 1911 the parasites had increased in numbers so that nearly one half of the cocoons examined were infested. So far only three adults, all males, have been reared. They are small, four-winged flies, metallic green in color and about 1½ mm. in length. This species has recently been described as *Derostenus salutaris* (Can. Ent., XLIII, p. 414).

Technical description.—Derostenus salutaris Crosby. (Fig. 38.) Male. Length 1½ mm. Head, thorax, and abdomen bright metallic green, the latter darker and bluish in certain lights. Head viewed from above strongly convergent behind the eyes and strongly concave posteriorly; the occiput bounded by a distinct ridge bearing a row of blackish hairs. Viewed from in front the inner margin of the eyes sinuate. Antennæ inserted near the mouth and separated by a distinct median carina. Head finely shingled and clothed with sparse short dark-colored hairs. Eyes finely pubescent.

Thorax more distinctly shingled and clothed with a few rather long brownish hairs. Propodeum with a median carina and a transverse carina before the apex; no lateral carina present.

Antennæ dark, nearly black; scape white; ring-joint distinct; funicle of three nearly equal segments; club ovate, of three closely united segments, the last small and style-like; flagellum filiform. Legs white; coxæ metallic green. Wings hyaline, postmarginal vein about as long as the stigmal. Petiole of abdomen a little longer than hind coxæ, finely and densely punctate.

Abdomen viewed from above nearly circular, smooth and flattened. The first segment back of petiole about one third length of the abdomen, the others subequal.

RELATED SPECIES

The genus Nepticula, to which the plum leaf-miner belongs, contains over 40 species from the United States, while in the British Isles, where entomologists have given more attention to these minute moths, over 70 species are known. The larvæ of all species of this genus so far as known are leaf-miners, feeding within the leaf just below the upper epidermis. As a rule each species is confined to a particular food plant, or at most to two or three closely related food plants.

The following list gives the food plants of the American species of Nepticula as far as known:

N. amelanchierella Clemens. Juneberry (*Amelanchier canadensis*).
N. anguinella Clemens. Oak.
N. castaneæfoliella Chambers. Chestnut, white oak, chestnut oak.
N. caryæfoliella Clemens. Hickory.

N. clemensella Chambers. Sycamore.
N. condaliafoliella Busck. *Condalia ferrea.*
N. coryfoliella Clemens. Hazelnut.
N. cratægifoliella Clemens. Hawthorn.
N. dallasiana Frey and Boll. *Rubus.*
N. fuscotibiella Clemens. Willow.
N. juglandifoliella Clemens. Walnut.
N. latifasciella Chambers. Probably chestnut.
N. myricafoliella Busck. Wax myrtle (*Myrica cerifera*).
N. nyssæfoliella Clemens. Sour gum.
N. ostryæfoliella Clemens. Hop hornbean.
N. platanella Clemens. Sycamore.
N. platea Clemens. Oak.
N. pomivorella Packard. Apple and pear.
N. populetorum Frey and Boll. *Populus angulifera.*
N. prunifoliella Clemens. Wild cherry.
N. pteliacella Chambers. Shrubby trefoil (*Ptelia trifoliata*).
N. quercicastanella Chambers. White oak, chestnut oak, and chestnut.
N. quercipulchella Chambers. White oak.
N. rosæfoliella Clemens. Rose.
N. rubifoliella Clemens. *Rubus.*
N. saginella Clemens. Oak.
N. serotinælla Chambers. Wild plum (*Prunus serotina*).
N. slingerlandella Kearfott. Cultivated plum and prune.
N. villosella Clemens. *Rubus villosus.*
N. virginiella Clemens. Hop hornbean.

A European plum leaf-miner.— *Nepticula slingerlandella*, the American form, is closely related to the European species *N. plagicolella* Stainton, which also feeds on the cultivated plum. The moth of *N. slingerlandella* differs from *plagicolella* in having the marginal cilia of the wings much whiter; the facia across the forewing is a silvery white, while in *plagicolella* it has a distinctly golden hue. In the American species the color of the forewing is distinctly black with a bronzy hue, while in *plagicolella* it is narrowly before the fascia and altogether beyond it of a reddish purple bronzy hue.

The following account of the European plum leaf-miner is condensed from an extended summary of its habits by J. W. Tutt (British Lepidoptera, 1, pp. 272–275. 1899).

Adult.— Head reddish. Anterior wings 4-5 mm.; shining fuscous with a purple tinge nearly from the base; beyond the middle is a nearly straight, shining, rather silvery, transverse fascia; cilia dark blackish gray. Posterior wings and cilia pale gray.

The egg is laid on the upper side of a sloe leaf.

Mine.— When newly hatched, the larva commences a long and extremely slender mine, which, being filled with blackish excrement, appears almost as a crooked black line; but, after continuing in this linear track for some distance, the larva mines a complete blotch of an irregular oval figure, and of a pale greenish white color; in the central portion of this blotch the black excrement forms a little heap; not unfrequently two larvæ, mining in the same leaf, will meet at the blotch portion of the mine, and have a larger blotch in common. The larva leaves its mine to spin its cocoon.

Larva.— Length 2 lines. Pale amber, shining, transparent, dorsal vessel slightly greener; head small, reddish brown, working up under the prothorax, through the upper surface of which the posterior part can be distinctly seen.

Cocoon.— The cocoons average 3 mm. in length and 1.75 mm. in width, forming a long oblong oval. There is a wide flange around the three sides of the cocoon, one of the long sides being almost devoid of it, however. This side rises directly to the highest point of the domed surface which surmounts the flange, the elevation being more gradual on the other side. The domed area is comparatively smooth, with a few fine, slender, irregular reticulations, rather darker than the ground color; the latter is ochreous brown, inclined to yellowish. There is a considerable amount of loose flossy silk of the same color as the silk of the cocoon scattered over the flange, a similar, but much thinner, coating covering the domed surface.

There are two broods, the adults appearing in May, June, and August, the larvæ of these feeding respectively in September-October and July-August.

MEANS OF CONTROL

The plum leaf-miner has proved to be a difficult insect to control, owing to the fact that from the time the larva leaves the egg it feeds entirely within the leaf out of reach of any poison spray. Measures directed against the moths, eggs, and larvæ have all proved failures, and only partial success has been attained by thorough cultivation to destroy the larvæ and pupæ in their cocoons.

Attempts to kill the moths.— As the moths rest during the day in great numbers on the bark of the trunk and larger branches, it seemed feasible at first to kill them with a contact spray. At the suggestion of Professor Slingerland, Mr. Hooker tested this method in May and June, 1909, using whale-oil soap, 30 pounds in 150 gallons of water. He did this work very thoroughly, using two double nozzles and spraying from two sides of the tree at the same time. While many moths were killed, many more escaped and the infestation on these trees was as bad as in previous years. The dead moths were to be seen still sticking to the bark late in the summer.

At the suggestion of P. J. Parrott, of the Geneva Experiment Station, " Tree Tanglefoot " was tried on a few trees. This sticky substance was spread on the bark of the tree with the hope of capturing the moths that normally rest in this situation. Its use was abandoned because it did not catch enough moths and because of the labor required to apply it to such a large surface. It also gave the trees an unsightly appearance.

Attempts to kill the eggs.— The eggs appear so delicate that we thought it might be possible to kill them with some contact spray. On June 9, 1910, we sprayed three trees thoroughly with " Nico Fume " tobacco extract, 1 ounce in 5 gallons of water, adding two cakes of laundry soap to each 25 gallons of the mixture. At this time the eggs were abundant but no mines were visible, showing that the eggs had not yet begun to hatch. Especial care was taken to hit the underside of the leaves where the eggs are deposited. An examination of these trees later in the season showed that this spraying did practically no good; the sprayed trees were as badly infested as the unsprayed. It may be that a spray stronger in nicotine would be more effective. No further experiments were made along this line.

Attempts to kill the larvæ in the mines.— In view of the fact that it is possible to kill the larvæ of the Elm Sawfly Leaf-miner (*Kaliosysphinga ulmi* Sundeval) while in their mines by spraying the leaves with a nicotine and soap solution, we thought the same treatment might be effective against the smaller and apparently more delicate plum leaf-miner. Accordingly, on July 6, 1911, we sprayed 32 trees thoroughly with " Blackleaf 40 " tobacco extract, 1 part in 800 parts of water, adding about 2 pounds of whale-oil soap to each 50 gallons. At that time about one half of the larvæ had left the mines and most of those remaining in the leaves were in the blotch part of the mine, protected only by the thin outer layer of the leaf. An examination of these trees twenty-four hours later showed that less than 10 per cent of the larvæ had been killed.

Cultivation as a means of control.— Early in the progress of this work Professor Slingerland (Proc. N. Y. State Fruit Growers' Association, p. 122, 1909) thought that this pest might be controlled by thorough cultivation of the ground beneath the trees after July 15 and during May. This would scatter and bury the majority of the cocoons. As the moth is a very delicate creature it would probably be unable to reach the surface after leaving the cocoon if covered by even a thin layer of earth.

As stated above, the heavy infestation of the Hooker orchard was probably induced by the strip of undisturbed sod beneath the trees, which afforded ideal winter protection to the cocoons. Acting on Professor Slingerland's suggestion, the owners plowed up the strip of sod under the trees in the fall of 1909, and have continued thorough cultivation both in fall and spring since that time. Beneficial results of this cultivation were not apparent in 1910. The trees were as badly infested as in former years. This was due, in part at least, to the fact that the soil close around the trees, where the greatest number of cocoons occur, was not disturbed. In the fall of 1910 they had their men hoe around the trees, but in many cases they failed to disturb the cocoons lying between the base of the trunk and the surrounding soil. In spite of this fact the number of moths issuing in the spring of 1911 was much smaller than in former years. This decrease may be due in part to the presence of the parasites mentioned above.

The present season the orchard has again received thorough cultivation, and the hoeing around the base of the trees has been more thorough; this precaution, together with the great increase in the number of parasites found in the cocoons, will probably lead to the elimination of the plum leaf-miner as a pest in this orchard.

In the present state of our knowledge it does not seem probable that the plum leaf-miner will ever become a general or serious enemy of the plum. If it should appear in other orchards, clean and persistent cultivation will probably prevent its becoming established in injurious numbers.

In conclusion, the writer wishes to thank Messrs C. M. Hooker & Sons for their hearty cooperation in conducting the work and for many suggestions of great practical value. Mr. C. M. Hooker was one of the first to use paris green against cankerworms on apple trees, and was probably the first to introduce its use into Western New York. The following entry copied from his diary is of historic interest: "June 7, 1873. Applied 15 parts flour, 1 part paris green, to apple trees in stump lot to destroy the cankerworms. Had a fine shower yesterday. Worms all killed next day."

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Department of Animal Husbandry

THE PRODUCTION OF "HOTHOUSE" LAMBS

Under the direction of
HENRY H. WING

By E. S. SAVAGE and G. W. TAILBY, Jr.

ITHACA, N. Y.
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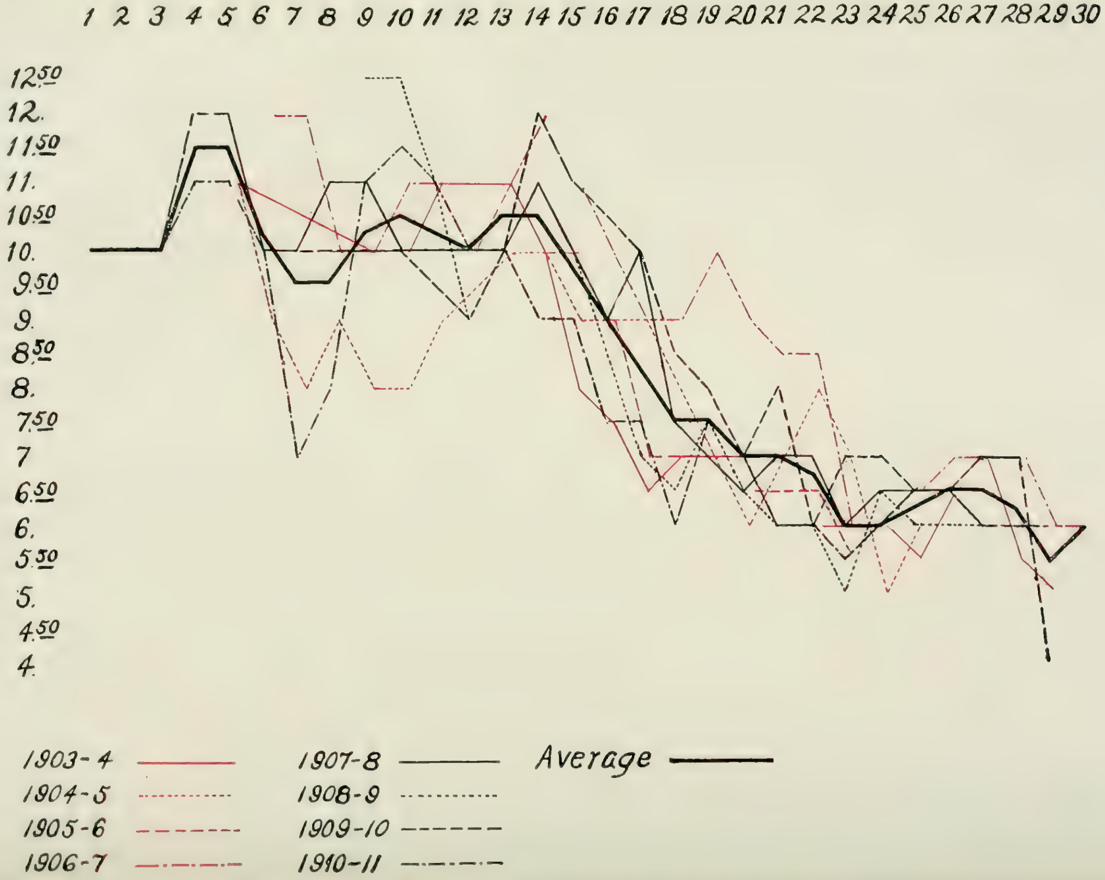
PLATE I. VARIATIONS IN QUOTATIONS, HOTHOUSE-LAMB MARKET, 1903-1904 TO 1910-1911, WITH AVERAGE. SEASON OF 30 WEEKS, FROM THE THIRD WEEK IN NOVEMBER TO THE SECOND WEEK IN JUNE



THE PRODUCTION OF "HOTHOUSE" LAMBS

E. S. SAVAGE AND G. W. TAILBY, JR.

The natural time for sheep to drop their lambs is in the spring. Reproduction in most of our domestic animals may be controlled at will by the breeder, but this is not entirely true of the ewe. She will sometimes breed to drop her lamb as early as October or November, but as a rule she cannot be made to breed until the fall, to drop her lamb the following spring.

Restaurant keepers and hotel men, always on the lookout for rarities and for meats of an unusual nature with which to tempt their guests, have created a demand during the months from December to May for young lambs weighing about thirty-five pounds when dressed. This market has grown to its greatest proportions in Boston, New York, and Washington. The lambs are sold by the carcass and not by the pound. The prices in the eight seasons 1903–1904 to 1910–1911 have ranged from $4 for a lamb sold late in the season to $12.50 for a prime lamb sold at the top of the market. (Table 1, p. 247.)

For the purpose of studying this business as a profitable kind of sheep husbandry for the New York farmer, the flock at Cornell University has been managed as a hothouse-lamb flock for several seasons. The results of this practice for the eight seasons 1903–1904 to 1910–1911 form the basis of the discussion set forth in the following pages. The bulletin has been divided into three parts: Part I deals with the care and management of the flock; Part II contains the record of the product during the eight seasons covered; and Part III is made up of tabulations of the data.

PART I

CARE AND MANAGEMENT OF THE CORNELL UNIVERSITY HOTHOUSE-LAMB FLOCK

The term "hothouse lamb" as here applied has probably been derived from the fact that these lambs, born late in the fall and in the early winter, are essentially an artificial product and are analogous to the products of our greenhouses or hothouses in that they are propagated out of their natural season for a market willing to pay almost any price for an unusual product. The term has, however, no reference to the quarters in which the business is conducted, for the best success has been attained in quarters that were in no way artificially heated.

In discussing the care and management of such a flock, it has seemed best to take up the matter according to the season and to carry the discussion through the full calendar year, beginning with the spring management after the winter's crop of lambs has been butchered.

Spring management

After the lambs have been taken away, the ewes are put on a ration of hay alone for two or three weeks and their udders are watched carefully to see that no trouble arises from caked udder. In some cases it may be necessary to milk out the ewe once a day, and later once every third day until she is dry. Then the ewes are fed a few roots to keep them in good condition until they are turned to pasture for the summer.

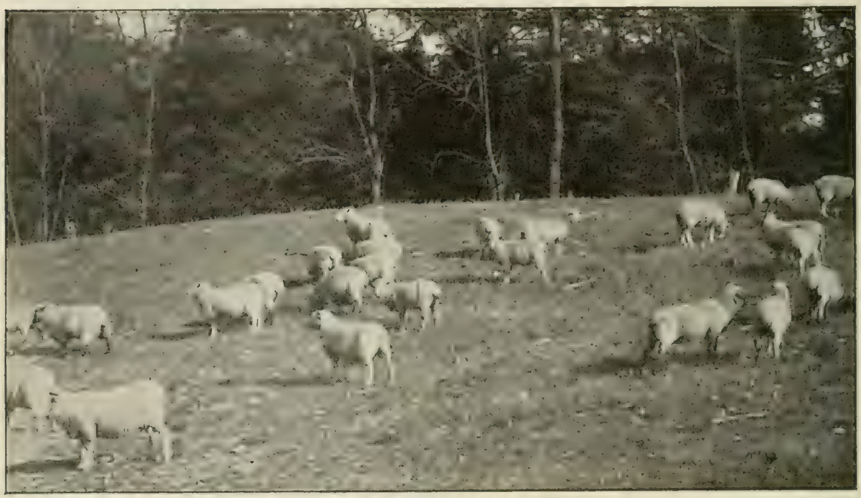


FIG. 39.—*Part of hothouse-lamb flock at pasture*

Summer management on pasture

The pasture season has ordinarily opened about May 15. When the ewes are turned to pasture the rams have been turned with them. The flock has been allowed to run together until the fall, when it is put into winter quarters. During the winter the rams have been quartered separately. The flock has been made up of representatives of several breeds, both pure-bred and grade. Ordinarily three pure-bred rams, a Hampshire, a Southdown, and a Horned Dorset, have been allowed to run with the flock.

No particular method of getting the ewes to breed early has been followed, since it has never been clearly shown that one method has proved better than another. Therefore the ewes and the rams have been turned together and allowed to breed at will. The only precaution taken has been to see that the ewes were in as good a condition as possible when turned out, and that the rams were young and active. The results from this treatment of the flock have been good.

No attention has been paid to what cross would be the most profitable, since all the lambs have been slaughtered for market and none have been kept for breeding purposes, the flock being maintained by purchase. Three rams have been kept with the flock for the reason that competition among the rams makes them more active.

Care has been taken that the ewes should have access to plenty of water and should receive plenty of salt. Late in the pasture season the pasture has been supplemented with green foods of different kinds, varying with the year: rape, cabbage, beet tops, and other green foods have been used to good advantage in this way. The whole object in feeding the ewes after they have become pregnant is to make "dairy" sheep of them: that is, to put them in condition to give as much milk as possible for the use of the lamb.

Fall and winter management

The fall and winter management of the flock may be discussed together, under four heads: the care of the rams; the care of the ewes; the care of the young lambs; slaughtering and marketing the lambs.

Care of the rams.—When the flock is taken from pasture the rams are separated and quartered separately until the next pasture season. They have received no particular care except to see that they were kept in good condition. It has not been found necessary to feed them anything except a good quality of hay, together with clean water and a sufficient amount of salt.

Care of the ewes.— Until they have lambed, the ewes have been fed clover hay alone unless they were out of condition, in which case a small amount of grain has been fed immediately after taking them from pasture. They have been put into dry, clean, well-ventilated pens, each pen containing from ten to fifteen ewes. The pens have been so protected that the water provided for the ewes has seldom frozen, the temperature rarely falling below 40° F. The pens have been cleaned once or twice during the season, and sufficient bedding has been provided to keep them dry at all times. Salt has always been supplied.

The lambs have been dropped in the regular pens, although it has been thought that it would be better to provide an artificially warmed lambing pen to provide against chilling the newborn lamb before he gets dry. The lambs are all right as soon as they get dry and up on their feet, if the temperature in the pen does not go below 20° F.

After the lambs are born, the ewes with their lambs have been penned together and the ewes fed grain and some succulent food. Each pen has usually contained eight to ten ewes and their lambs. The size of these pens is about ten by fifteen feet. The grain ration has always been made up nearly in accordance with the following formula: 60 pounds of wheat bran, 30 pounds of corn meal, and 10 pounds of old-process oil meal. Sometimes the proportions have been changed or other grains have been added, but the above formula is a representative one for the ewes. They have been fed lightly at first and then increased to two or three pounds per head per day. Besides clover hay for roughage, it has been the practice to provide roots, feeding about two pounds of sliced turnips or mangels per head per day. It has been thought that turnips gave better results than did mangels. When no roots have been available, silage has been fed in the same amount, two pounds per head per day, with good success.

As mentioned before, the best food to keep the lamb growing is his mother's milk, and the main object in feeding the ewe at this point is to get the greatest possible milk-production. Care must be taken that neither the lamb nor his mother shows signs of scouring; such signs exhibited by either indicate overfeeding of the ewe. Careful shepherding at all times is the keynote of success with this kind of sheep husbandry.

Care of the young lambs.— No matter what the size of the hothouse lamb may be, he will not top the market unless he is fat. In order to attain this condition, as indicated above, the best food is his mother's milk and plenty of it; this must be supplemented with grain, however, as the lamb grows. At different times the following mixtures have been tried:

(1) 50 pounds of corn meal, 50 pounds of wheat middlings, and 5 pounds of oil meal;

(2) 25 pounds of wheat bran, 25 pounds of wheat middlings, 25 pounds of hominy chop, and 8 pounds of oil meal;

(3) When the lambs were one month old, 45 pounds of whole corn, 45 pounds of whole oats, and 10 pounds of oil cake, pea size. When this last mixture was used it was fed once a day, after which the trough was swept out clean and a mixture like No. 1 or No. 2 was fed once daily. No advantage was found in the use of No. 3, and therefore its use has been discontinued of late and mixtures like No. 1 or No. 2 have been relied on entirely.

The lambs have been provided with a separate place for eating their grain, which is usually called a creep. This is simply an arrangement of a little pen alongside the large pen, into which the lambs may go but the ewes may not. Here the lambs have been provided with grain at all times. At first it may be necessary to sprinkle a little sugar over the grain. The little lambs will soon learn to like it and those that learn to eat it first will soon teach the others. It has been the practice to keep grain before the little lambs at all times, yet to be careful that it is never fouled in any way. Success depends on the little ones' eating well all the time and growing fatter every minute of their short lives.

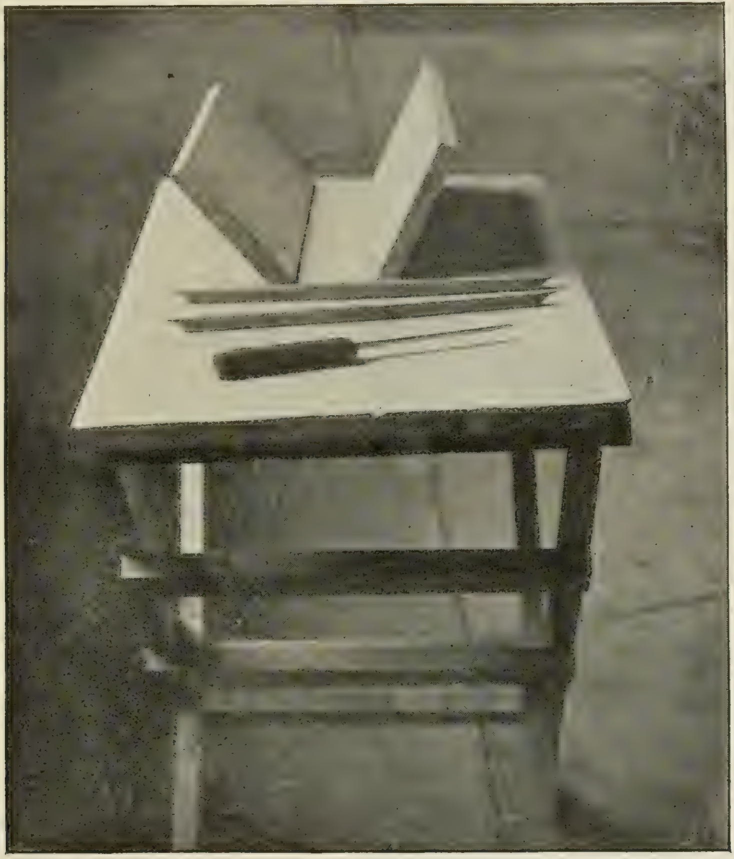


FIG. 40.—*Dressing table, knife and backsets*

The lambs usually grow rapidly enough to be ready for slaughter in seventy to seventy-five days from birth. They should be made to grow fast enough to gain at least one half pound per day during this time and to reach a slaughter weight of 45 to 48 pounds at the end of the time (Table 4).

This short discussion covers the main points in the year round management of a hothouse-lamb-producing flock as it has been conducted at Cornell University. Before discussing the data obtained that serve to show the practice above outlined as good, it remains to describe the method of slaughtering the lamb for market.

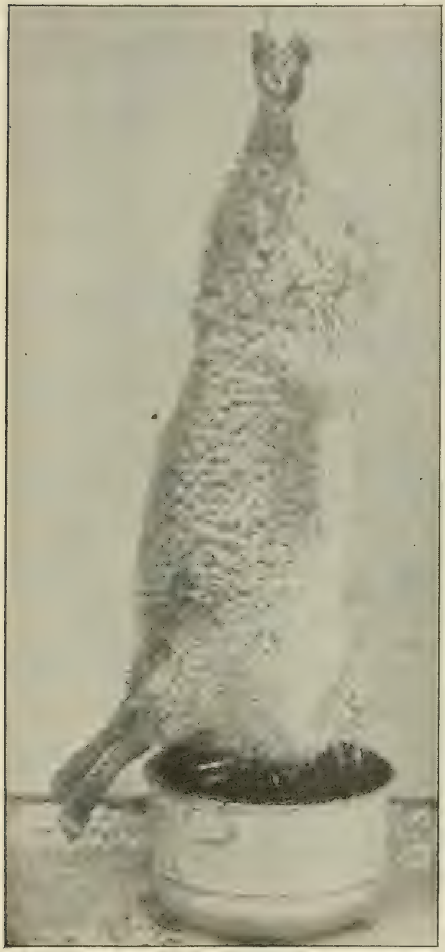


FIG. 41.—*Method of bleeding the lamb*

Slaughtering and marketing the lambs.— The hothouse-lamb market is a special market commanding a high price and the variations at the top are large. The market is fastidious, hence small things count for much. The results of good shepherding and good feeding, ending in a plump lamb in fine condition, may be discounted twenty-five per cent through carelessness in slaughtering and in preparing for market. Here care and cleanliness must prevail. For the New York market the slaughtering must be done late Saturday afternoon or Sunday, if the weather is warm, so that the lamb may be cooled out and wrapped for shipment by express on Monday. It has been found most advantageous to sell on Tuesday's or Wednesday's market. It is always best to sell on the wholesale market, which closes Friday noon; therefore the lambs must be on the market by Wednesday at the latest.

The lambs are "hog-dressed," that is, most of the pelt is left on, the head and feet are cut off, and the stomach, spleen, intestines, bladder, and gall bladder are removed. The lamb is taken directly from his mother.

In slaughtering, bleeding is much more satisfactory if the lamb is suspended. A thin-bladed knife (Fig. 40) is the only tool necessary. The following method has been found good practice in slaughtering:

Fasten the hind legs together and hang up the lamb. Insert the knife close to the backbone near the angle of the jaw, at the same time dislocating the neck. This will stun the lamb and prevent spattering the carcass with blood. With the first stroke of the knife, cut completely through the under part of the neck. Then sever the head completely from the neck (Fig. 41).

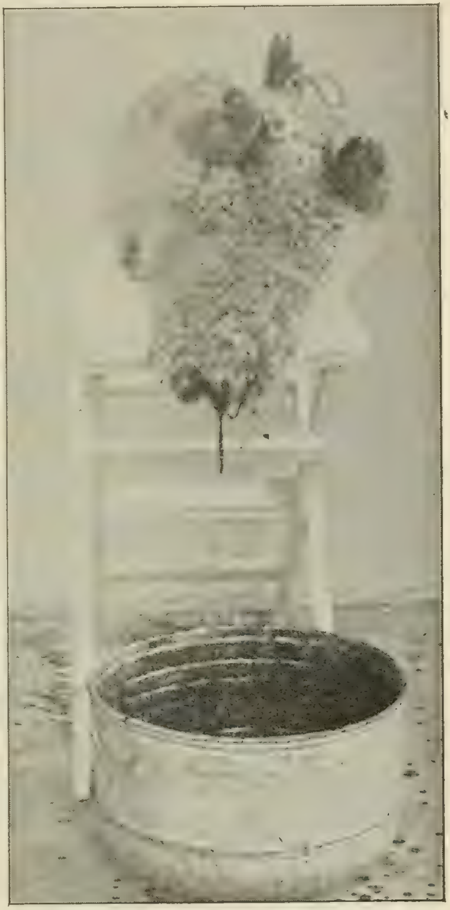


FIG. 42.—*Lamb on dressing table*

Place the lamb on his back on a suitable trough-shaped table (Fig. 42). Cut through the skin from breast to back of scrotum, to angle of hind leg, and loosen the skin. Remove a triangular-shaped piece of skin in the angle of the hind leg where the skin is free from wool. Remove the skin around the rectum, on the underside of the tail for a little distance down the tail, and on the inside of the hind legs, leaving it attached to the rectum. Then pull the rectum straight out. Remove a narrow strip from gamble to pastern, cut off the hind legs at the ankle joint, and loosen the gambles. Cut off the front legs at the knee joint nearest the foot, which gives a flat surface. Leave a little flap of skin on the front of the leg to fold back over the knee joint after the leg has been removed.

Hang up the lamb and make an incision from in front of the scrotum or udder to the breastbone. Remove omentum or caul as the intestines roll out (Fig. 43). The omentum is the layer of fat covering the viscera. It may be removed as a whole, and should be kept clean for use in covering the exposed parts of the carcass when dressing is finished and backsets have been adjusted.

Remove the intestines, stomach, spleen, bladder, and gall bladder. The liver is left in. Then split down the breastbone and make an incision into the chest in order to cool it out. In all the work of skinning and dressing the lamb, be very careful to remove none of the fat from the body.

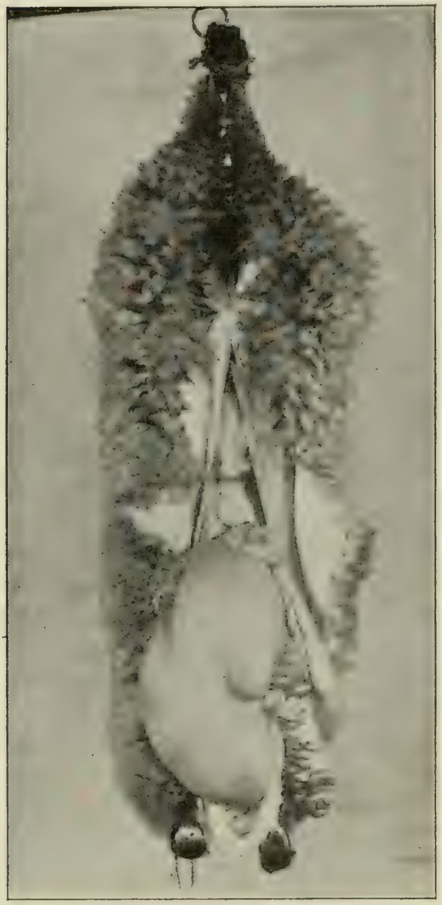


FIG. 43.—*Removing the entrails. The caul is shown at the bottom of the picture*

The final thing to do is to spread the carcass with two sticks called backsets. These sticks are 13 to 15 inches long, according to the size of the lamb. They are best when made of ash, hickory, or red oak. A good size is one made of one of the above woods and sawed $\frac{1}{4}$ x $\frac{3}{4}$ inch, 12 to 15 inches long, sharpened to a fine point with a shoulder at either end (Fig. 40). In spreading the carcass, the sharp point of one end of the backset is inserted in the loose skin near the breastbone, carried back of the body, and inserted in the turned back flank on the other side. The second backset is then inserted in the same way, crossing the first on the back of the carcass. The caul is then spread over the exposed parts of the carcass in front, fastening it to the four points of the backsets, and pulling it into the crotch of the hind legs (Fig. 44).

The carcass should next be hung in a cool place until it is thoroughly cold. Twenty to twenty-four hours is usually sufficient. In midwinter a lamb can be cooled out in twelve hours. When thoroughly cold the carcass is ready to be wrapped and shipped.

The carcass is first wrapped in unbleached muslin. One square yard is sufficient for each carcass. This is used to cover the exposed parts only. The method of putting on the cloth is shown in Figs. 45 and 46. After the muslin is adjusted, the whole carcass should be wrapped in burlap and sewed up securely to keep it clean (Fig. 47). The carcasses are usually shipped by express in order to insure prompt delivery and to get them promptly on the market early in the week.

PART II

RECORD OF THE PRODUCT

In Part I the methods of handling the hothouse-lamb flock at the Cornell University farm have been outlined. In Part II it is aimed to show that these methods have produced good results. The time of marketing to obtain the highest prices may be first discussed.

Time to market

The average of eight seasons' quotations shows that the time to market hothouse lambs is before March 4 (Table 1 and Plate I). On the average the price begins a steady decline about March 4 and does not again recover. Before March 4 the price varies somewhat on the average, and still more in individual seasons. This means that in order to top the market the lambs must be born before January 1. The top price for the eight years was $12.50, quoted in the third and fourth weeks of January, 1909. The average up to March 4 for all the eight seasons has not varied widely from $10 per carcass (Table 1).

So far as the product of the Cornell flock is concerned, out of a total of 261 lambs raised as winter lambs in eight years, 60, or 23 per cent, have been sold before March 4 — a creditable percentage when the difficulty of getting the ewes to breed in the early summer is taken into account (Table 2). This leads us to the data on the number of lambs that have been sold on the hothouse-lamb market out of the total number of lambs born.

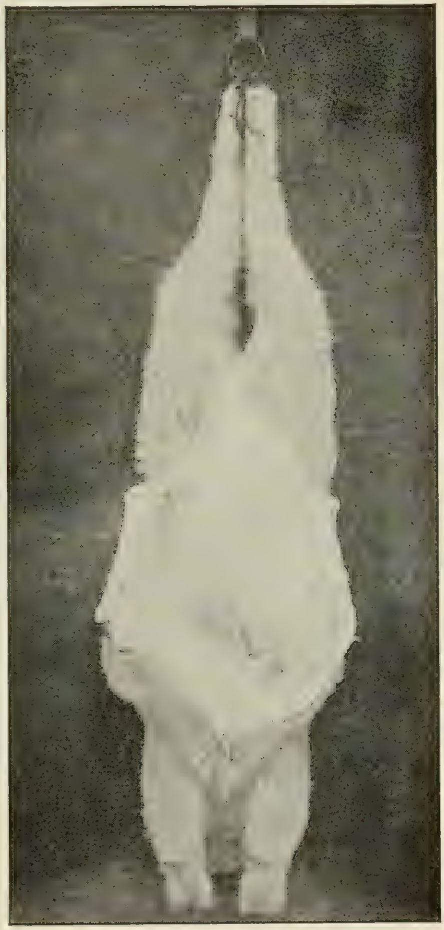


FIG. 44.—*The caul properly spread over the carcass*

Percentage of lambs dropped early at the Cornell University farm

There have been born in this flock, in the eight seasons, a total of 401 lambs. Of these, 261, or 65.1 per cent, have been marketed as hothouse lambs. This takes into account those that have died at birth as well as those born too late to reach the hothouse-lamb market. This percentage of 65.1 out of all the lambs born shows that fair success has been attained by the method of turning three rams with the flock and leaving them in the pasture during the entire summer.

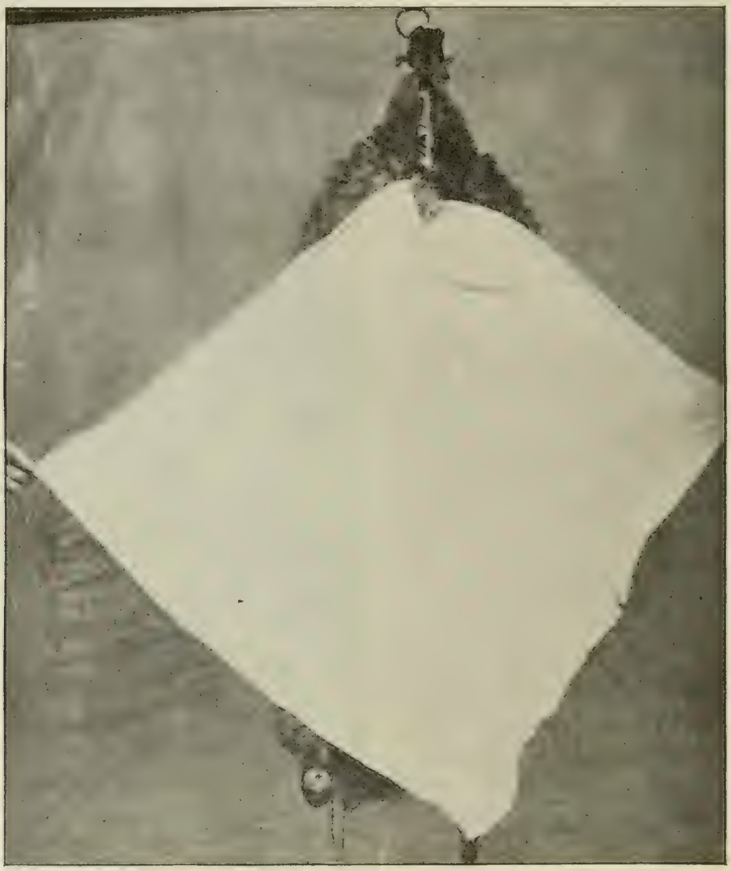


FIG. 45.—*Method of covering the carcass with muslin*

Necessary gain per day

The records show that the best prices are obtained for lambs that have gained an average of at least one half pound per day. The fluctuation above and below the highest quotation at the time when each lamb was sold has been correlated with the gain per day. Disregarding those lambs that were sold at the highest quotation each week, it has been found that of those remaining less than 50 per cent have been sold above quotation, until those making a gain of one half pound per day or more are considered. From then on it is found that 50 per cent or more, disregarding those sold on quotation, have been sold above quotation (Table 5).

Weight at which to slaughter

A study of the records has been made in order to show the proper weight at which to slaughter the lambs to get the best price. From this study it is clear that the lambs should reach a weight of 48 to 50 pounds before slaughtering. Disregarding those sold at the highest price quoted, of those slaughtered at a weight of 46 to 48 pounds, 59.6 per cent sold under the highest quotation and 40.4 per cent sold above quotation. Of those lambs weighing less than 46 pounds at slaughter, a still greater percentage was sold below the highest quotation. Considering those lambs that weighed at slaughter more than 49 pounds, we have over 50 per cent selling above quotation. If those sold at the highest quoted price are considered, it is more clearly shown that the lambs must attain a weight of nearly 48 pounds before slaughtering (Table 6).

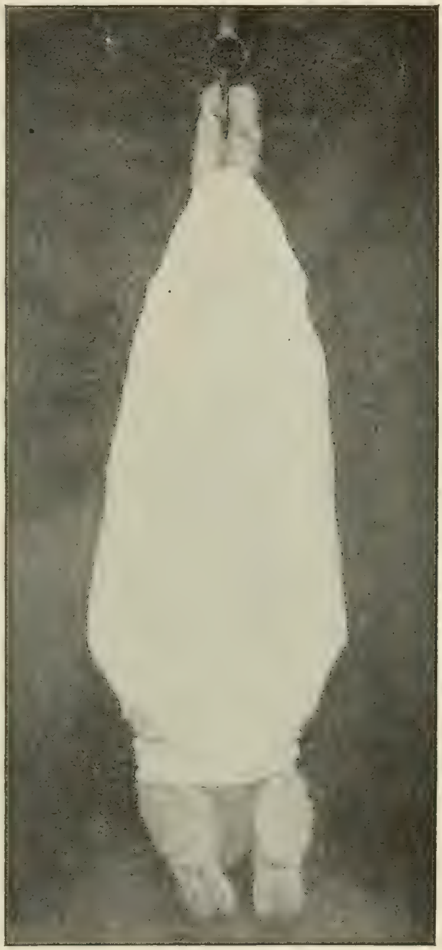


Fig. 46.—*Carcass wrapped in muslin*

The best breed for hothouse-lamb production

There now remains the consideration of the data that will show the results in the Cornell flock as to breed. It has been shown that one of the most important phases of the subject of hothouse-lamb production is getting the ewes to breed early. The records have been studied to see if this is in any way a breed characteristic. It has been shown (Table 1 and Plate I) that March 4 is the date when the high prices received for hothouse lambs during the early winter begin to decline. If the percentage of lambs from each breed slaughtered before that date is calculated and compared with the percentage slaughtered after that date, it will throw some light on the breeds that breed the earliest.

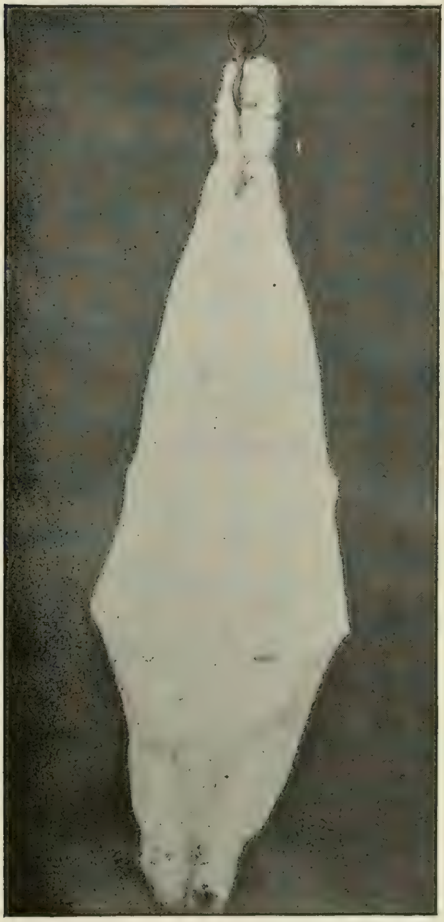


FIG. 47.—*Carcass wrapped in burlap ready for shipment*

The ewes that breed the earliest

From the records it is shown that of the total number of hothouse lambs produced, 42.8 per cent of those born from grade Dorset ewes were slaughtered before March 4 and from the other ewes in the following order: from pure-bred Dorsets, 34.8 per cent; from pure-bred Rambouillets, 33.3 per cent; from pure-bred Delaines, 33.3 per cent; from grade Cheviots, 31.2 per cent; from pure-bred Shropshires, 23.1 per cent; from the other ewes, the highest percentage of lambs sold was 12.9 per cent from the grade Shropshires (Table 2).

In order, then, from the standpoint of earliness of production, the breeds stand as follows: Horned Dorsets, both pure-bred and grades, Rambouillets, Delaines, grade Cheviots, and Shropshires. If both pure-bred and grade Cheviots were considered together, the pure-bred Cheviots would lower the average of the breed so that the Shropshires would stand ahead of them (Table 2). The most successful hothouse-lamb breeders are using Horned Dorset and fine-wooled ewes.

Percentage from each breed marketed as hothouse lambs out of total number born

Out of the total number of lambs born from the ewes of the different breeds, 93.3 per cent of those born from the grade Dorsets were marketed as hothouse lambs; 81 per cent from the Delaines; 76.9 per cent from the Rambouillets; 76.2 per cent from the grade Cheviots; 70.8 per cent from the pure-bred Dorsets; 69.2 per cent from the Cotswolds; 66.6 per cent from the Hampshires; 59.6 per cent from the grade Shropshires; 59 per cent from the grade Southdowns; 55.8 per cent from pure-bred Southdowns; 50 per cent from the pure-bred Shropshires; and 46.9 per cent from the pure-bred Cheviots (Table 3).

Again, taking both pure-breds and grades of each breed into consideration, the breeds would stand in the following order: Dorsets, Delaines, Rambouillets, Cotswolds, Hampshires, Cheviots, Southdowns, and Shropshires.

The data for weight at birth, weight at slaughter, total gain, number of days growth, gain per day, selling price, and highest price at the time each lamb was sold, have all been averaged and are interesting to study; but the individual variations are so great that no conclusions can be drawn as to the comparative value of the different breeds.

From the above studies the conclusion is clear that the best results in hothouse-lamb production would be with the Horned Dorset, the Delaine, and the Rambouillet breeds, mainly because of their early breeding habits and from the fact that the ewes of these breeds are excellent mothers.

Records of some individual ewes

Some of the ewes in the flock have made exceptional records. These records are reviewed to show what is possible with some ewes.

A grade Dorset ewe, No. 98 (Tables 3 and 4), has the best record. She produced ten lambs in eight seasons. All of these lambs were raised early enough to be marketed on the hothouse-lamb market, where they brought a total of $94. If they had sold at the highest quoted price for the weeks in which they were sold, they would have brought $86. This denotes that the offspring of this ewe sold well above the quotation. The records show that this ewe raised every lamb born from her, and produced milk enough to keep the lambs gaining an average of .56 pound each per day.

A pure-bred Dorset ewe, No. 607 (Tables 3 and 4), produced nine lambs in five years and raised eight of them early enough to be marketed as hothouse lambs. They sold a little below the highest quoted price, bringing a total of $73.52, when if sold at the highest quoted price they would have brought $75.52. Notwithstanding the fact that three years out of the five there was a pair of twins to be fed, the eight lambs made an average gain per day of .51 pound each.

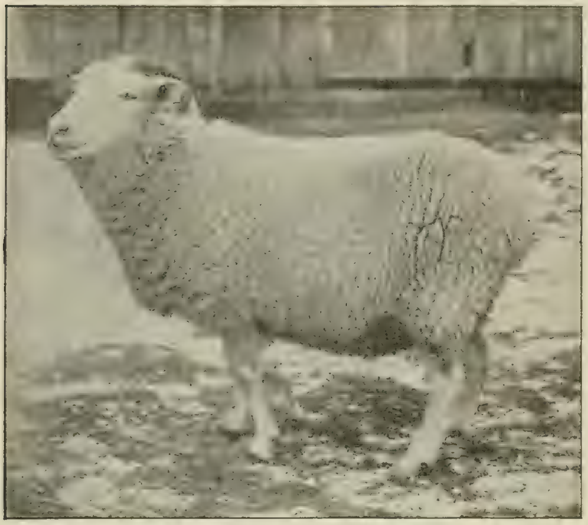


FIG. 48.—*Dorset ewe No. 607*

A pure-bred Dorset ewe, No. 7,475 (Tables 3 and 4), produced ten lambs in seven years, of which seven sold as hothouse lambs for $55.02. The total of the highest quotations when these lambs were sold was $55.02, showing that they averaged to sell at the highest price quoted when they were marketed. These lambs averaged a gain of .51 pound each daily. No. 7,475 was the mother of No. 607, whose record is given just above.

A Rambouillet ewe, No. 5 (Tables 3 and 4), raised seven lambs out of eight born in seven years. These seven lambs made an average gain of .48 pound each per day. They were sold for $42.49 when the quotations totaled $49.98. This shows that they were sold somewhat below quotation, a fact that may be partly explained by the low gain per day.

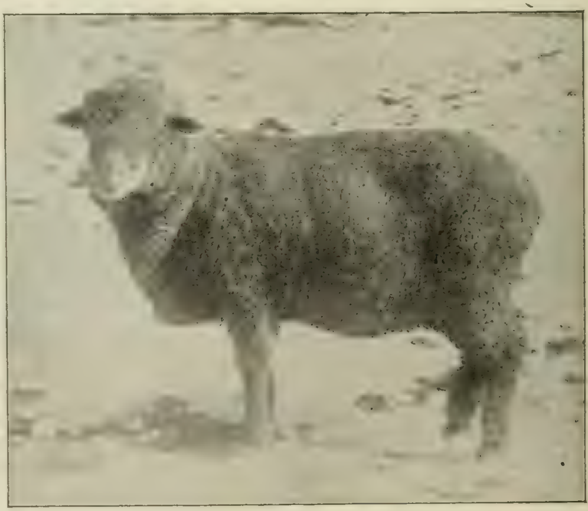


FIG. 49.—*Rambouillet ewe No. 5*

A Delaine ewe, No. 318 (Tables 3 and 4), raised seven out of eight lambs born in six years. They made an average gain per day of .49 pound each. They sold for a total of $46.48 when quoted at a total of $48.02. This also may be due to the fact that the average daily gain was below .50 pound.

FIG. 50.—*Delaine ewe No. 318*

A grade Southdown ewe, No. 316 (Tables 3 and 4), produced eleven lambs in seven years. Seven of these were raised as hothouse lambs and sold for $40.95 when the quotations called for a total of $44.87. These lambs made a daily gain of .40 pound each.

A grade Southdown ewe, No. 376 (Tables 3 and 4), produced ten lambs in six years, of which seven sold as hothouse lambs for $47.53. The total of the highest quotations when these lambs were sold was $50.47. These lambs averaged a daily gain of .49 pound each.

FIG. 51.—*Grade Southdown ewe No. 316*

A grade Shropshire ewe, No. 360 (Tables 3 and 4), produced eight lambs in five years, of which seven were sold as hothouse lambs for $53.97. The total of the highest quotations when these lambs were sold was $58.52. These lambs made a gain of .47 pound each daily.

From no other ewe in the flock have more than six hothouse lambs been sold. For comparison with the work of these exceptional ewes the average production of the flock has been calculated. In the eight years during which records have been kept, eighty-four ewes have been producing hothouse lambs. Some of these ewes have been in the flock only one year, while others have been in the flock the full time. The average length of time that each ewe has been in the flock has been 3.88 years. The eighty-four ewes have produced a total of 401 lambs, of which 261 have been sold as hothouse lambs. The average selling price has been $7.52 and the average quotation $7.78. The average number of lambs sold as hothouse lambs from each ewe has been 3.1. These, at $7.52, the average selling price, have brought $23.31. Calculated from this amount by dividing by 3.88, the annual income per sheep has been $6.

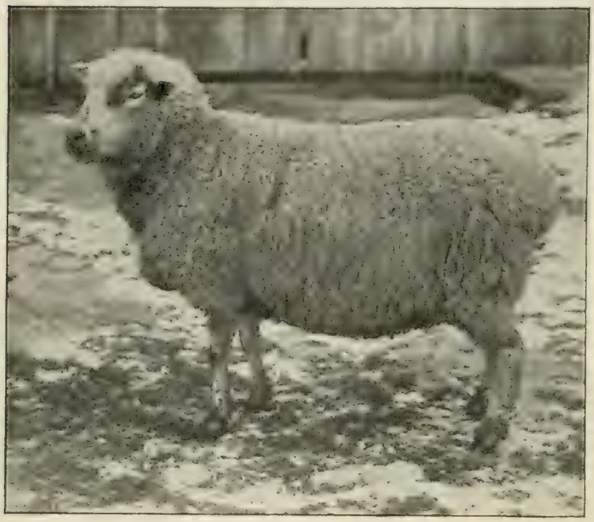


FIG. 52.—*Grade Shropshire ewe No. 360*

These figures indicate that this type of sheep husbandry is a good one to follow. Seven dollars and fifty cents is a good price for a lamb at two months of age. Not all of the lambs are born early enough to be sold on the hothouse-lamb market, but they can be used for ordinary purposes if they are born late.

An average yearly income per sheep of $6 besides the amount that her wool will bring should pay a farmer well for food and labor. The time over which the records extend, eight years, is long enough to make the averages accurate, and they form a good basis for judging of the value of this industry to the farmer.

PART III

TABULATIONS OF DATA

TABLE 1. MARKET FOR HOTHOUSE LAMBS

Saturday quotations from third week in November to second week in June, all seasons from 1903–1904 to 1910–1911

	Nov.		Dec.				Jan.					Feb.				March				April					May				June	
Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1903–1904	..	..	..	.....	11.	.....	.....	.....	10.	10.	11.	11.	11.	10.	8.	7.50	6.50	7.	7.	7.	6.	6.	6.	5.	5.50	6.50	7.	*5.50	5.*	..
1904–1905	..	..	..	.....	11.	9.	8.	9.	8.	8.	9.	9.50	10.	10.	9.	9.	9.	8.	7.	6.	7.	8.	7.*	5.*	*6.	.....	.....	.....	.....	..
1905–1906	..	..	..	.....	.....	.....	.....	10.	10.	10.	10.	10.	11.	10.	10.	9.	7.	7.	7.	6.50	6.50	6.50	5.50	6.	*6.50	*6.50	6.*	*6.	6.*	..
1906–1907	..	..	..	.....	.....	12.	12.	10.	10.	11.	11.	11.	11.	12.	11.	10.	9.	9.	10.	9.	8.50	8.50	6.	6.	6.50	7.	7.	7.	6.	6
1907–1908	..	..	..	.....	12.	10.	10.	11.	11.	10.	10.	10.	10.	11.	10.	9.	10.	7.50	7.	6.50	7.	7.	6.	6.50	6.50	6.50	6.50	.....	.....	..
1908–1909	..	..	..	.....	.....	.....	.....	.....	12.50	12.50	11.	9.	10.	11.	10.	8.50	7.	6.50	7.50	6.50	6.	6.	5.	6.50	6.	6.	6.	6.	6.	..
1909–1910	10	10	10	12.	12.	10.	10.	10.	10.	10.	9.50	9.	10.	12.	11.	10.50	10.	8.50	8.	7.	8.	6.	7.	7.	6.50	6.50	7.	7.	4.	..
1910–1911	10	10	10	11.	11.	10.	7.	8.	11.	11.50	11.	10.	10.	9.	9.	7.50	7.50	6.	7.50	7.	6.	6.	5.50	6.	6.50	6.50	6.	.....	.....	..
Average..	10	10	10	11.50	11.40	10.20	9.40	9.60	10.30	10.40	10.30	9.90	10.40	10.60	9.75	8.90	8.25	7.40	7.60	6.90	6.90	6.75	6.	6.10	6.25	6.50	6.50	6.30	5.40	6

* Quoted as spring lambs per carcass.

TABLE 2. CORRELATION: BREED AND EARLINESS OF SLAUGHTER

Date of slaughter	Dorset	Grade Dorset	Hampshire	Cotswold	Rambouillet	Cheviot	Grade Cheviot	Delaine	Southdown	Grade Southdown	Shropshire	Grade Shropshire
Dec. 10–16	2	......	....	....	......	....	......	......	......	......	......	......
Dec. 17–23	2	1	....	....	......	....	2	......	......	......	......	......
Dec. 24–30	......	......	....	....	......	....	......	......	......	......	......	......
Dec. 31–Jan. 6	......	......	....	....	......	....	......	1	......	1	......	......
Jan. 7–13	2	1	....	....	1	....	......	1	1	......	1	1
Jan. 14–20	1	......	....	....	......	....	......	......	......	......	......	......
Jan. 21–27	......	......	....	....	......	....	......	1	......	......	1	......
Jan. 28–Feb. 3	1	......	....	....	......	....	......	......	......	......	......	......
Feb. 4–10	1	......	....	....	......	....	......	1	......	......	......	......
Feb. 11–17	1	3	....	....	1	....	1	3	......	1	......	......
Feb. 18–24	3	......	....	....	2	....	......	1	......	......	......	2
Feb. 25–Mar. 3	3	1	....	1	6	....	2	2	1	1	1	1
Mar. 4–10	7	1	....	....	1	2	1	1	3	......	1	3
Mar. 11–17	3	2	1	....	4	1	1	3	......	2	......	......
Mar. 18–24	1	1	....	....	1	2	1	2	1	3	......	1
Mar. 25–31	5	......	....	1	2	....	......	2	......	2	4	1
April 1–7	1	1	2	....	3	....	1	3	3	3	3	5
April 8–14	5	1	....	....	2	2	2	1	3	1	1	6
April 15–21	2	......	1	4	2	7	3	4	2	3	1	5
April 22–28	1	1	....	1	2	2	2	2	1	1	......	......
April 29–May 5	1	1	....	2	1	5	......	1	2	4	......	3
May 6–12	2	......	....	....	......	....	......	1	1	1	......	1
May 13–19	......	......	....	....	1	....	......	......	......	1	......	2
May 20–26	1	......	....	....	......	1	......	......	......	2	......	......
May 27–June 2	1	......	....	....	1	1	......	......	1	......	......	......
Total	46	14	4	9	30	23	16	30	19	26	13	31
Number sold before March 4	16	6	0	1	10	0	5	10	2	3	3	4
Per cent sold before March 4	34.8	42.8	0	11	33.3	0	31.2	33.3	10.5	11.5	23.1	12.9

TABLE 3. PERCENTAGE OF LAMBS RAISED AS HOTHOUSE LAMBS

FROM DORSET EWES							FROM GRADE DORSETS						
	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs		Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	280	3	3	3	0	0		96	2	1	0	1	100
	281	1	0	0	0	0		97	1	1	0	1	100
	282	6	5	4	1	20		98	8	10	0	10	100
	311	1	1	0	1	100		273	1	1	1	0	0
	312	6	8	2	6	75		726	2	2	0	2	100
	356	3	4	2	2	50							
	604	4	7	1	6	86							
	607	5	9	1	8	89							
	616	4	5	1	4	80							
	617	4	8	2	6	75							
	632	4	5	0	5	100							
	7,475	7	10	3	7	70							
Total	12	1 to 7	65	19	46	70.8	Total	5	1 to 8	15	1	14	93.3
Average	......	4	5.4	1.6	3.8	70.8	Average	......	2.8	3	.2	2.8	93.3

FROM HAMPSHIRES

	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	19,586	2	2	1	1	50
	73	1	1	0	1	100
	80	1	1	0	1	100
	81	1	2	1	1	50
Total . .	4	1 to 2	6	2	4	66.6
Average	. . . . . .	1.3	1.5	.5	1.0	66.6

FROM DELAINES

	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	318	6	8	1	7	87.5
	963	8	7	2	5	71
	993	7	7	1	6	86
	997	4	4	1	3	75
	1,060	5	4	0	4	100
	1,100	7	7	2	5	71
Total . .	6	4 to 8	37	7	30	81
Average	. . . . . .	6.2	6.2	1.2	5	81

FROM SOUTHDOWNS

	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	358	5	6	2	4	66.6
	378	8	10	8	2	20
	604	4	4	0	4	100
	605	4	5	2	3	60
	851	8	9	3	6	67
Total . .	5	4 to 8	34	15	19	55.8
Average	. . . . . .	5.8	6.8	3	3.8	55.8

FROM GRADE SOUTHDOWNS

	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	79	6	7	3	4	57
	313	5	7	6	1	14
	316	7	11	4	7	63
	376	6	10	3	7	70
	828	2	2	2	0	0
	829	1	1	0	1	100
	830	6	6	0	6	100
Total . .	7	1 to 7	44	18	26	59
Average	. . . . .	4.7	6.3	2.6	3.7	59

FROM COTSWOLDS

	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	248	4	4	1	3	75
	256	1	2	2	0	0
	848	4	3	0	3	100
	849	2	2	0	2	100
	850	2	2	1	1	50
Total . . .	5	1 to 4	13	4	9	69.2
Average	. . . . . .	2.6	2.6	.8	1.8	69.2

FROM RAMBOUILLETS

	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	5	7	8	1	7	87.5
	7	1	1	0	1	100
	57	2	2	2	0	0
	107	2	3	2	1	33.3
	143	6	6	0	6	100
	248	3	4	0	4	100
	249	3	5	2	3	60
	292	3	3	0	3	100
	294	3	3	0	3	100
	295	3	4	2	2	50
Total . .	10	1 to 7	39	9	30	76.9
Average	. . . . . .	3.3	3.9	.9	3	76.9

FROM SHROPSHIRES

	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	144	4	5	2	3	60
	217	6	6	4	2	33.3
	218	3	3	2	1	33.3
	223	5	5	1	4	80
	606	5	7	4	3	43
Total...	5	3 to 6	25	13	13	50
Average.	......	4.6	5.2	2.6	2.6	50

FROM GRADE SHROPSHIRES

	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	95	3	4	1	3	75
	100	1	2	2	0	0
	269	5	7	3	4	57
	270	1	2	2	0	0
	271	1	1	0	1	100
	272	2	2	0	2	100
	276	3	4	1	3	75
	277	1	2	2	0	0
	340	2	2	0	2	100
	341	5	10	5	5	50
	360	5	8	1	7	87.5
	608	8	8	4	4	50
Total..	12	1 to 8	52	21	31	59.6
Average	......	3.1	4.3	1.7	2.6	59.6

FROM CHEVIOTS

	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	64	6	6	4	2	33.3
	68	6	8	3	5	62.5
	70	6	11	6	5	45
	76	6	10	7	3	30
	77	2	2	2	0	0
	601	4	4	2	2	50
	602	4	4	1	3	75
	603	4	4	1	3	75
Total..	8	2 to 6	49	26	23	46.9
Average	......	4.7	6.1	3.2	2.9	46.9

FROM GRADE CHEVIOTS

	Ewe no.	Years in flock	Total lambs dropped	Total lambs too late or died	Total lambs raised as winter lambs	Per cent lambs raised as winter lambs
	50	3	3	0	3	100
	60	3	5	3	2	40
	94	3	3	0	3	100
	339	2	3	0	3	100
	352	5	7	2	5	71
Total...	5	2 to 5	21	5	16	76.2
Average.	......	3.2	4.2	1	3.2	76.2

TABLE 4. AVERAGE DATA FOR THE OFFSPRING OF EACH EWE AND FOR EACH BREED

DORSETS

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	0	280	.....	.....	.....	.....	.....	......	......
	0	281	.....	.....	.....	.....	.....	......	......
	1	282	13.0	51.0	38.0	70.0	.54	$8.00	$6.50
	1	311	11.0	46.0	35.0	66.0	.53	5.00	10.00
	6	312	9.9	53.0	43.1	71.0	.61	9.50	9.58
	2	356	11.8	50.0	38.2	64.5	.59	7.75	8.75
	6	604	8.3	47.3	39.0	75.0	.52	7.50	7.92
	8	607	9.7	47.6	37.9	74.2	.51	9.19	9.44
	4	616	7.4	49.3	41.9	94.3	.44	6.00	7.63
	6	617	7.7	48.6	40.9	74.8	.55	7.00	7.58
	5	632	9.9	49.2	39.3	63.6	.62	9.10	9.00
	7	7,475	9.4	48.0	38.6	76.0	.51	7.86	7.86
Total....	46	.....	425.5	2250.4	.....	3410.6	.....	$370.54	$390.54
Average..	....	.....	9.3	48.9	39.6	74.1	.54	8.06	8.49

GRADE DORSETS

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	1	96	9.5	45.0	35.5	72.0	.49	$5.00	$6.00
	1	97	10.9	48.0	37.1	59.0	.63	11.00	11.00
	10	98	9.3	48.2	38.9	69.6	.56	9.40	8.60
	0	273	.....	.....	.....	.....	.....	......	......
	2	726	9.2	51.5	42.3	82.0	.52	8.50	8.50
Total....	14	.....	131.8	678.0	.....	991.0	.....	$127.00	$120.00
Average..	....	.....	9.4	48.4	39.0	70.8	.55	9.07	8.57

HAMPSHIRES

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	1	19,586	10.4	49.0	38.6	67.0	.58	$6.50	$5.50
	1	73	11.9	47.0	35.1	62.0	.57	7.00	6.50
	1	80	9.7	49.0	39.3	54.0	.73	7.00	7.00
	1	81	6.7	45.0	38.3	66.0	.58	7.00	6.50
Total....	4	.....	38.7	190.0	.....	249.0	.....	$27.50	$25.50
Average..	....	.....	9.7	47.5	37.8	62.3	.61	6.88	6.38

COTSWOLDS

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	3	248	10.5	52.0	41.5	62.3	.67	$6.33	$6.17
	0	256	.....	.....	.....	.....	.....	......	......
	3	848	10.6	47.0	36.4	60.3	.60	7.50	8.00
	2	849	11.0	48.5	37.5	59.0	.64	6.75	6.25
	1	850	8.8	42.0	33.2	82.0	.40	4.00	7.00
Total....	9	.....	94.1	436.0	.....	567.8	.....	$58.99	$62.01
Average..	....	.....	10.5	48.4	37.9	63.1	.61	6.55	6.89

RAMBOUILLETS

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	7	5	9.8	46.7	36.9	76.3	.48	$6.07	$7.14
	1	7	9.0	44.0	35.0	84.0	.42	5.00	7.00
	0	57	.....	.....	.....	.....	.....	......	......
	1	107	10.7	43.0	32.3	62.0	.52	10.00	9.00
	6	143	10.6	45.2	34.6	69.0	.50	8.16	8.50
	4	248	8.2	48.0	39.8	77.2	.52	8.00	7.87
	3	249	7.8	52.0	44.2	66.6	.66	8.17	8.00
	3	292	10.5	43.8	33.3	63.3	.53	8.00	8.83
	3	294	11.0	53.3	42.3	74.0	.57	9.83	9.50
	2	295	11.4	45.0	33.6	73.5	.46	7.75	8.75
Total....	30	.....	295.4	1414.4	.....	2161.6	.....	$231.95	$244.95
Average..	....	.....	9.8	47.1	37.3	72.1	.52	7.73	8.17

CHEVIOTS

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	2	64	11.1	46.0	34.9	71.0	.49	$7.00	$7.25
	5	68	8.8	45.8	37.0	72.8	.51	7.35	7.10
	5	70	5.7	45.0	39.3	92.2	.43	5.20	6.40
	3	76	8.6	47.0	38.4	79.6	.48	5.67	6.00
	0	77	.....	.....	.....	.....	.....	......	......
	2	601	6.6	45.5	38.9	71.0	.55	7.25	8.50
	3	602	8.2	45.3	37.1	66.3	.56	6.33	6.17
	3	603	11.1	46.3	35.2	66.0	.53	7.33	7.33
Total....	23	.....	191.6	1052.8	.....	1744.7	.....	$149.24	$157.50
Average..	....	.....	8.3	45.8	37.5	75.8	.49	6.49	6.85

GRADE CHEVIOTS

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	3	50	10.3	49.7	39.4	58.0	.68	$10.00	$9.00
	2	60	9.5	43.5	34.0	73.5	.46	6.25	7.00
	3	94	11.0	47.9	36.9	61.0	.60	7.17	6.83
	3	339	8.5	46.0	37.5	65.3	.57	7.83	7.17
	5	352	9.8	49.8	40.0	66.6	.60	8.80	8.50
Total....	16	......	157.4	766.8	.....	1032.9	.....	$131.50	$125.50
Average..	....	.....	9.8	47.9	38.1	64.6	.59	8.22	7.84

DELAINES

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	7	318	10.0	47.1	37.1	75.6	.49	$6.64	$6.86
	5	963	9.5	48.4	38.9	82.0	.47	7.10	7.50
	6	993	10.6	45.6	35.0	68.5	.51	9.08	9.58
	3	997	11.0	45.3	34.3	74.0	.46	7.50	8.50
	4	1,060	10.6	45.0	34.4	74.0	.46	7.38	7.88
	5	1,100	8.6	47.8	39.2	94.8	.41	8.70	8.40
Total....	30	.....	299.5	1400.2	.....	2342.2	.....	$231.98	$242.02
Average..	....	.....	10.0	46.6	36.6	78.1	.47	7.73	8.07

SOUTHDOWNS

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	4	358	9.8	49.0	39.2	68.3	.57	$9.12	$8.62
	2	378	9.7	46.5	36.8	74.0	.50	7.63	8.00
	4	604	9.7	48.8	39.1	69.0	.57	7.75	7.63
	3	605	7.8	47.0	39.2	89.6	.44	5.50	6.00
	6	851	10.5	48.3	37.8	69.3	.55	6.75	7.00
Total....	19	.....	183.8	915.0	.....	1381.8	.....	$139.74	$141.00
Average..	....	.....	9.7	48.2	38.5	72.7	.53	7.36	7.42

GRADE SOUTHDOWNS

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	4	79	9.8	46.8	37.0	67.5	.55	$7.38	$7.63
	1	313	9.2	51.0	41.8	76.0	.55	6.00	6.00
	7	316	8.7	47.7	39.0	97.5	.40	5.85	6.41
	7	376	9.5	48.3	38.8	78.4	.49	6.79	7.21
	0	828	.....	.....	.....	.....	.....	......	......
	1	829	7.8	50.0	42.2	69.0	.61	8.00	7.00
	6	830	9.8	49.5	39.7	69.0	.58	7.92	7.93
Total....	26	.....	242.4	1257.2	.....	2060.3	.....	$179.52	$186.44
Average..	....	.....	9.3	48.3	39.0	79.2	.49	6.90	7.17

SHROPSHIRES

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	3	144	10.9	45.7	34.8	61.0	.57	$7.83	$8.50
	2	217	8.8	47.0	38.2	64.5	.59	9.00	9.00
	1	218	10.7	41.0	30.3	69.0	.44	3.50	7.00
	4	223	9.6	51.0	41.4	71.0	.58	8.38	8.25
	3	606	10.1	47.3	37.2	65.3	.57	6.00	6.66
Total....	13	.....	129.7	618.0	.....	860.9	.....	$96.51	$103.48
Average..	....	.....	10.0	47.5	37.5	66.2	.57	7.42	7.96

GRADE SHROPSHIRES

	Number of lambs	From ewe no.	Av. wt. at birth (lbs.)	Av. wt. at slaughter (lbs.)	Av. gain (lbs.)	Av. days growth	Av. gain per day (lbs.)	Av. selling price	Av. quotation
	3	95	7.1	43.0	35.9	87.0	.41	$6.00	$7.00
	0	100	.....	.....	.....	.....	.....	.....	......
	4	269	9.3	45.3	36.0	75.8	.47	7.00	6.88
	0	270	.....	.....	.....	.....	.....	......	......
	1	271	10.5	43.0	32.5	46.0	.71	7.50	7.50
	2	272	10.8	45.0	34.2	62.5	.55	7.75	7.75
	3	276	10.7	43.0	32.3	71.3	.45	5.66	6.66
	0	277	.....	.....	.....	.....	.....	......	......
	2	340	12.2	44.0	31.8	51.5	.62	8.00	8.25
	5	341	7.5	47.2	39.7	84.8	.47	6.80	7.10
	7	360	8.2	47.0	38.8	82.0	.47	7.71	8.36
	4	608	10.0	52.3	42.3	63.0	.67	7.00	7.38
Total....	31	.....	282.0	1434.4	.....	2302.1	.....	$217.95	$231.54
Average..	....	.....	9.1	46.3	37.2	74.2	.50	7.03	7.47

TABLE 5. Correlation: Gain per Day with Amount above or below Highest Quotation

Gain per day (lbs.)	.26–.30	.31–.35	.36–.40	.41–.45	.46–.50	.51–.55	.56–.60	.61–.65	.66–.70	.71–.75	.76–.80	.81–.85
$5.00 below quotation	...	...	...	...	...	*1	...	...	...	...	...	....
4.50 “ “	...	...	...	...	...	...	...	...	...	...	...	....
4.00 “ “	...	...	...	...	...	...	...	...	...	1	...	....
3.50 “ “	...	...	1	2	...	...	...	...	...	...	...	....
3.00 “ “	...	...	1	2	...	...	...	...	...	...	...	....
2.50 “ “	...	...	2	...	1	...	...	...	...	...	...	....
2.00 “ “	1	2	1	4	...	1	...	...	...	...	...	....
1.50 “ “	...	3	6	3	7	1	3	...	1	...	1	....
1.00 “ “	...	1	3	8	7	13	1	2	...	...	...	....
.50 “ “	1	...	2	8	3	2	5	2	1	1	1	....
.00 “ “	...	1	2	6	9	18	10	9	7	3	1	1
.25 above quotation	...	...	...	1	...	1	...	...	...	...	...	.....
.50 “ “	...	...	3	1	3	7	9	8	9	2	2	1
1.00 “ “	...	...	...	...	1	8	5	5	2	2	...	1
1.50 “ “	...	...	1	1	...	3	...	...	1	1	...	1
2.00 “ “	...	...	...	...	...	...	2	1	2	...	1	....
Total, disregarding those sold at quotation	2	6	20	30	22	37	25	18	16	7	5	3
Per cent below quotation	100	100	80	90	81.8	48.7	36	22.2	12.5	28.6	40	....
Per cent above quotation	...	...	20	10	18.2	51.3	64	77.8	87.5	71.4	60	100

* Spoiled after slaughter.

TABLE 6. Correlation: Weight at Slaughter with Amount above or below Highest Quotation, 1903–1904 to 1910–1911

Weight at slaughter (lbs.)	37–39	40–42	43–45	46–48	49–51	52–54	55–57	58–60	71
$5.00 below quotation	....	....	....	*1	....	....	....	....	.....
4.50 “ “	....	....	....	....	....	....	....	....	.....
4.00 “ “	....	....	....	....	....	....	....	....	1
3.50 “ “	....	1	1	....	1	....	....	....	.....
3.00 “ “	....	3	....	....	....	....	....	....	.....
2.50 “ “	....	....	....	3	....	....	....	....	.....
2.00 “ “	1	3	4	1	....	....	....	....	.....
1.50 “ “	....	5	3	8	3	4	....	....	.....
1.00 “ “	1	5	19	9	3	....	....	....	.....
.50 “ “	....	....	6	6	10	1	3	....	.....
.00 “ “	1	3	15	25	15	4	5	1	.....
.25 above quotation	....	....	....	2	....	....	....	....	.....
.50 “ “	....	....	12	9	13	7	4	1	.....
1.00 “ “	1	1	5	3	8	3	1	1	.....
1.50 “ “	....	....	....	4	4	....	....	....	.....
2.00 “ “	....	....	....	1	3	1	1	....	.....
Total, disregarding those sold at quotation	3	18	50	47	45	16	9	2	1
Per cent sold below quotation	66.6	94.4	66	59.6	37.8	31.2	33.3	....	100
Per cent sold above quotation	33.4	5.6	34	40.4	62.2	68.8	66.7	100	.....

* Spoiled in marketing.

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SOY BEANS AS A SUPPLEMENTARY SILAGE CROP

A popular discussion for New York

BY EDWARD R. MINNS

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

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SOY BEANS AS A SUPPLEMENTARY SILAGE CROP

EDWARD R. MINNS

Soy beans have never been grown on many farms in New York. There are comparatively few localities in the State where the crop will grow well enough to compete with the commercial crops of these beans grown in the warmer latitudes of Ohio, Pennsylvania, and New Jersey. There are limited areas in New York where some of the earlier varieties of soy beans will mature 15 to 20 bushels of seed on an acre. Larger and somewhat later varieties can be grown to sufficient maturity for ensiling or soiling purposes. There is little opportunity to cure the plants for hay in September, the season when they are most valuable for feed. The most profitable use that can be made of the soy bean in this State is to ensile it with corn fodder before frost kills the foliage. For this purpose the culture of soy beans should be encouraged wherever the tendency is toward intensive dairy farming and the soil and climate are favorable for corn growing. It is the purpose of this bulletin to point out the reasons why soy beans are a good crop to supplement corn fodder in the silo, and how they have been successfully grown for this purpose by practical farmers in different parts of New York.

FEEDING VALUE OF SOY BEANS

As a forage crop, soy beans have been found very rich in protein. The seeds alone, when ground into meal, can be successfully substituted for equal amounts of linseed meal in feeding dairy cows.* Soy bean hay is shown by analysis to have a high percentage of protein and fat. At the Massachusetts Hatch Station, a comparison of the amounts of protein, fat, and carbohydrates produced on an acre each of soy beans and flint corn cut for green fodder, showed that the soy bean acre produced nearly 34 per cent more of protein than did the acre of corn; while the acre of corn produced over 84 per cent more of carbohydrates and fat than did the acre of soy beans. Ensilage made from corn alone is known to be a wide ration, and needs to be supplemented with foods richer than itself in protein in order to balance the ration. The Massachusetts test indicates how this may be done where both the corn and the soy beans can be grown to a reasonable degree of maturity and combined when filling the silo. It is not to be inferred that a mixture of the two crops will make it unnecessary or unprofitable to feed grain in the ration; but in practice it has been found possible to reduce the amount of grain fed to dairy cows and maintain the milk flow, if a portion of the ensilage consists of soy bean fodder. The digestibility of soy beans compares favorably with that of alfalfa and clover. Ensilage made from corn and soy beans has been found more digestible than that made from dent corn alone.* Because soy bean fodder is a high-protein feed that can be produced under practically the same conditions as can Indian corn, it deserves more attention from live-stock farmers, especially those feeding for milk production.

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*Bulletin 168, Virginia Agricultural Experiment Station.

SOY BEANS AS NITROGEN GATHERERS

The soy bean possesses, in common with other members of the legume family, the merit of utilizing the free nitrogen of the air through the formation of root tubercles in which live nitrogen-gathering bacteria. The crop will flourish and produce heavily on good fertile soil without the formation of tubercles on the roots; but unless the necessary bacteria are already present or are introduced into the soil when soy beans are planted, the crop cannot be expected to act as a gatherer of nitrogen from the air. The formation of tubercles on the roots of soy beans does not always result in an apparent increased growth of fodder. It may do so, or it may result in a fodder that is richer in nitrogenous compounds than that produced without tubercles. At the Wisconsin Agricultural Experiment Station, analyses of both roots

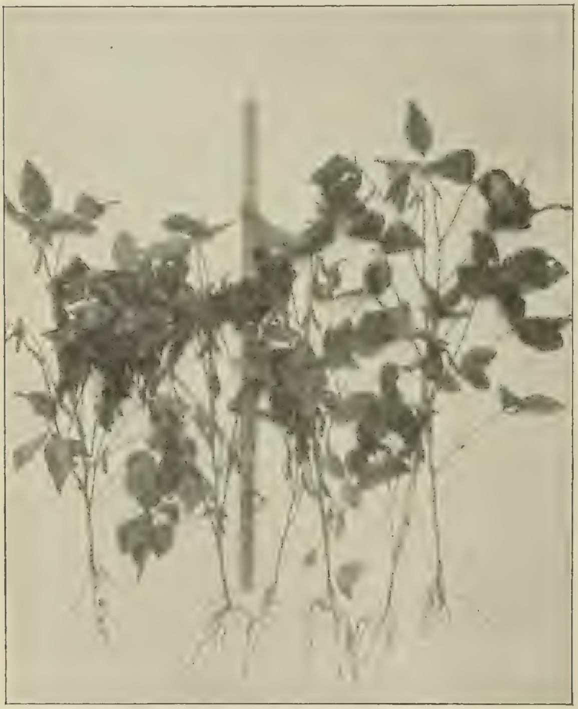

FIG. 53.—*Thrifty soy bean plants partially filled with seed pods. Clusters of tubercles on the roots were produced by soil inoculation*

and stalks of soy bean plants were made from inoculated and uninoculated crops. It was found that inoculated soy beans produced nitrogen valued at $2.34 more an acre than did the uninoculated soy beans.* The Michigan Agricultural Experiment Station made similar trials, in which it was found that inoculation increased the nitrogen in soy bean plants almost 50 per cent.†

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*"Feeds and feeding," by W. A. Henry.

The bacteria that cause tubercles to grow on other legumes, as alfalfa, clover, and peas, do not produce tubercles on soy bean plants. Tubercle bacteria adapted to the soy bean plant should be introduced in planting a field that has never grown soy beans. This may be done by scattering soil over it from a field that has grown inoculated soy beans, and harrowing it in before planting; or commercial cultures of soy bean bacteria may be used with success to inoculate the seed before planting.

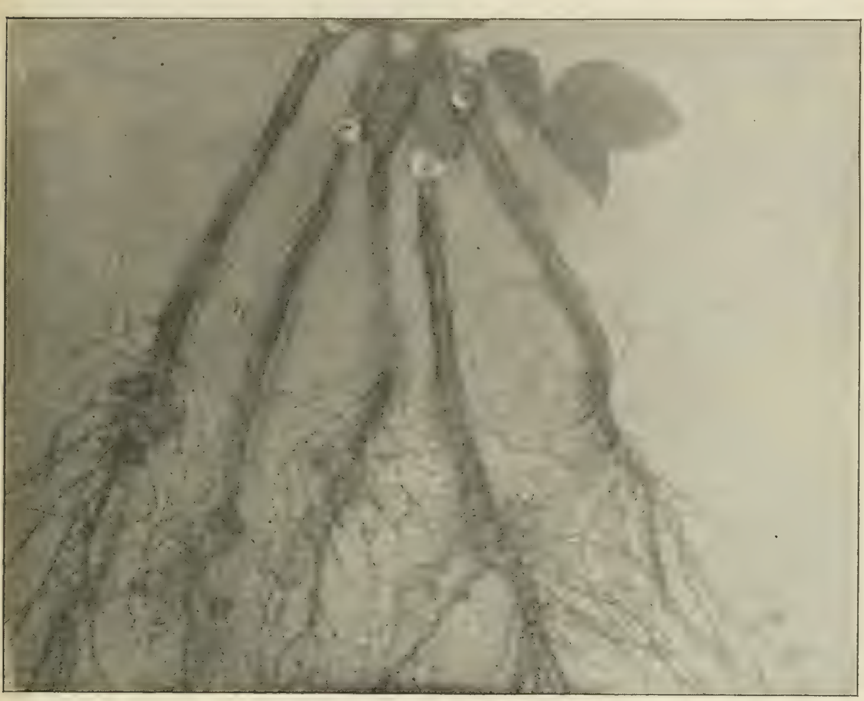

FIG. 54.—*Soy bean stems and roots showing the characteristic formation of tubercles due to seed inoculation*

There is some positive evidence that the growth of alfalfa and field peas associated with other plants increases the nitrogen content of the other plants.‡ In practice it has been noticed that the mixing of field

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*Wisconsin Agricultural Experiment Station Report, 1907, p. 162.
†Michigan Agricultural Experiment Station Bulletin 224.
‡Cornell University Agricultural Experiment Station Bulletin 294.

peas with oats, and red clover with timothy, results in benefit to the oats and timothy. A similar benefit to the growth of corn with which soy beans have been grown has been claimed by some persons. The writer has not seen any proved instances of this benefit.

It is not considered profitable to grow soy beans as a green manure crop in New York, but where a cultivated crop of soy beans has been removed, leaving the roots and tubercles in the ground, the available soil nitrogen is increased and the succeeding crop may be much benefited. The excellent growth of a crop of corn following soy beans on the university farm in 1911 was good evidence in support of this statement.

VARIETIES

The botanical name of the soy bean is *Glycine hispida*. The common name "soja bean," sometimes applied to this plant, is not correct. The soy bean originated in southeastern Asia and has been cultivated there for centuries. Seeds of its numerous varieties have been imported into the United States by the national Department of Agriculture, by some of the experiment stations, and by enterprising seedsmen. In a few cases, the seedsmen offered it to the public as a substitute for coffee under the name of "coffee berry." At the present time the majority of seed houses offer one or more varieties of soy or "soja" bean for sale. There are many varieties known. The variations in height, uprightness of growth, branching habits, leafiness, color and size of seeds, and time of maturity are considerable. The common names applied to many varieties in this country refer to the color of seed and the time of maturity. Generally, the earlier varieties do not grow very tall nor produce heavy crops of foliage. For New York conditions, some of the "early" and "medium" varieties are most likely to mature. For producing crops of ripe seed, the Ito San can be relied on; it is rather too small for use as a green forage crop. Of all the varieties tested for green forage purposes, the one known as Medium Green, Medium Early Green, and Early Green has given the most satisfaction. Bulletin 98, Bureau of Plant Industry, United States Department of Agriculture, gives the correct name of this variety as " Guelph." It does not seem likely that this name will come into general use, because the variety's easily recognized characters are so well described by its more common names. Out of several newer varieties tested at Ithaca during 1911, the Elton, a yellow-seeded variety, appears to be the equal of Ito San for seed production. The Auburn is a promising new black-seeded variety for green forage production. In time of maturity and general vigor of growth it compares favorably with the Medium Green variety. The Medium Yellow, or Mammoth Yellow as it is sometimes called, is later in maturing and the leaves were subject to attacks of disease in 1911.

From all our reports from farmers who have tried soy beans for forage, the Medium Green variety is best adapted to the purpose in this State.

SOILS AND CLIMATE FOR SOY BEANS

The soil requirements for soy bean growing do not seem to be any more limited than do the soil requirements for corn growing. The best and most profitable crops can be grown where the soil conditions are most suitable. It has been noted that soy beans have excellent drought-resisting qualities, and also that they will survive wet weather better than will corn.* The crop is hardier than the common field bean. It may be planted earlier, as early as the ground is warm enough for corn. It may be harvested later than field beans, and has been left out of doors exposed to winter weather without injuring all the seed. The writer found that out of a small field of Medium Green soy beans which had been pulled and bunched in autumn and left exposed in the field all winter, those pods that did not touch the ground contained normal and viable beans that were successfully used for seed in the fields the season following. The pods seem to give admirable protection from frost, rain, and snow.

CULTURAL METHODS

Soy beans respond readily to good cultivation. Without intertillage, their growth is likely to be disappointing. The method of cultivation best suited to the crop is similar to that used in growing common field beans. A mellow seed-bed, well smoothed by the harrow, is conducive to uniform depth in planting and to a good stand of plants. If the crop is to be grown alone, the seeds should be planted in drill rows far enough apart for horse cultivation. Rows 28 inches apart have been found satisfactory. In rows of this width the bean plants should not stand nearer than 1 inch apart. For seed production alone, more space is desirable. Wider space between rows may be used and the beans dropped closer together in the row. The drill row should be narrow in order to make it easier to control weeds by cultivating. A grain drill with hoes 7 inches apart may be used for sowing the seed. With every fourth hole in the seed box open, 28-inch rows will be sown. The seed may be covered one to two inches deep without harm if no pressure is applied afterward. The soy bean cotyledons force their way above ground more easily than do those of larger beans. The planting may be done as early as the ground is warm enough to plant corn, or as late as the middle of June, but only the early varieties can be expected to mature seed when planted so late in central New York. For seed production, 1 bushel of seed beans an acre is enough on good soil. For fodder or silage purposes, 1½ to 2 bushels of seed an acre will produce a larger yield of fodder.

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*United States Department of Agriculture, Farmers' Bulletin No. 58.

Cultivation between the rows should be begun as soon as the rows can be seen, and may be done close to the bean seedlings if shields are used to keep the loosened soil from covering them. Frequent shallow cultivation until the pods form and the plants branch out should be practiced. The growth of tall weeds and annual grasses with the beans is undesirable.

HARVESTING SOY BEANS

For silage or soiling purposes, the crop may be harvested with a side-delivery reaper or with a twine binder. The fodder is at its best for feed when the pods are mostly filled and the foliage has not yet begun to fall off. If ripe seed is desired, the plants should stand until the leaves have dropped. When the pods are tough with dampness, a reaper or a mower may be used to cut the ripe stalks. Curing in stacks so made as to shed water will be found best. Varieties that shatter badly when dry should be handled in the field only when damp enough to be tough. The Medium Green variety is very faulty in this respect. A thresher may be used to separate the beans from the pods and stalks, but if it is an ordinary grain thresher most of the concaves must be removed.

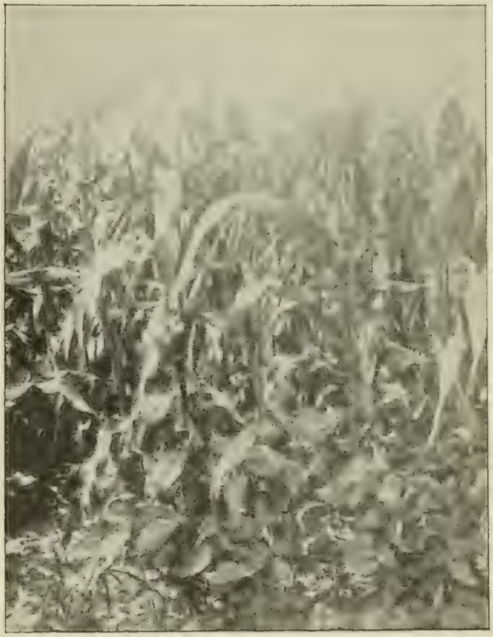

FIG. 55.— *Medium Green soy beans growing in the same row with Pride of the North dent corn. The yield of fodder was over 16 tons an acre. Season of 1908*

Soy beans cut for silage must be hauled from the field and mixed with corn fodder at the cutting box in order to have the mixture of corn and soy beans evenly distributed in the silo. In this way, any proportion of beans to corn may be made at will. It is not wise to use more than one load of beans to two of corn, and one to four will be found to enrich the silage noticeably. Soy beans alone, because of their high protein content, tend to make a strong-smelling, objectionable silage. Their dilution with corn fodder in the silo reduces the danger of strong odors, and makes the silage more nutritious, and not less palatable, than that from corn only. The yield of soy bean fodder cannot be so heavy as the yield of corn from the same ground. On a fixed area, therefore, the total yield of both corn and soy bean fodders will be less than if all corn were grown. In order to follow the above practice, the grower must either cultivate more acres or else be content with a smaller quantity of fodder in the silo.

The proposition to grow the soy beans in the same rows with the corn, and thus enrich the quality of the fodder without materially decreasing the yield, has been tried by a few farmers at different points in the State. In some instances the practice has been followed for a number of years with success; in others the successful association of soy beans with corn has been demonstrated, but the grower has not made use of the fact in a practical way. A brief account of the methods followed by a few farmers who have proved the value of the mixed crop is given here.

In 1905, a farmer at Millbrook, N. Y., began to plant corn and soy beans in hills by hand. The proportion was 4 kernels of corn to 6 soy beans in hills 36 x 40 inches. That season four acres of the mixed crop yielded 72 tons of fodder. The proportion by weight of corn fodder to soy bean fodder in the mixture was estimated to be about 5 to 1. In 1906, the mixed seed used was in the proportion of 4 or 5 of corn to 10 or 12 of soy beans per hill. The yield of fodder was not reported, but the proportion of corn fodder to soy bean fodder was slightly less than 5 to 1. In March of 1907, a sample of this silage was sent to the New York State Agricultural Experiment Station at Geneva for partial analysis. Doctor Van Slyke reported that the sample contained 4.22 per cent protein and 2.2 per cent crude fat.

The crop of 1907 seems to have had a normal growth of soy beans and a very poor growth of corn. The proportion of corn fodder to soy bean fodder based on the weight of 12 hills was 2 to 1. A sample of the silage analyzed at the Cornell University Experiment Station in February, 1908, showed higher percentages of solids, protein, fat, and carbohydrates than did the analysis of ordinary corn silage. The nutritive ratio was reported by Professor Cavanaugh as 1 : 6.75. During the last two years the practice of hand planting has been discontinued. The beans and corn are mixed in equal quantities and sown with a grain drill, in rows 3½ feet apart, using 20 quarts of the mixed seed to an acre. During the season of 1911 drought interfered with the growth of the crop, but a yield of 12½ tons of fodder an acre was harvested on a field of less than average productiveness for this farm. A light dressing of manure was plowed under and about ½ ton of lime was harrowed in during preparation of the field. Three hundred pounds to the acre of complete fertilizer was applied at planting time, and

300 pounds of basic slag to the acre was cultivated in when the corn was tasseling.

In the same neighborhood another farmer procured a horse-drawn corn planter, which dropped corn and soy beans in the same hill from separate boxes and distributed fertilizer at the same time. He planted sixteen acres with this machine in fifteen working hours, and the corn and beans came up as well as, or better than, when hand-planted. The machine was adjusted to drop 4 to 6 kernels of corn and 8 to 10 beans in a hill. For three years this practice was followed and yields estimated at 12 to 15 tons of the mixed fodder were secured. This farmer sold out his business recently, but continues to advocate the growing of soy beans and corn for the silo.

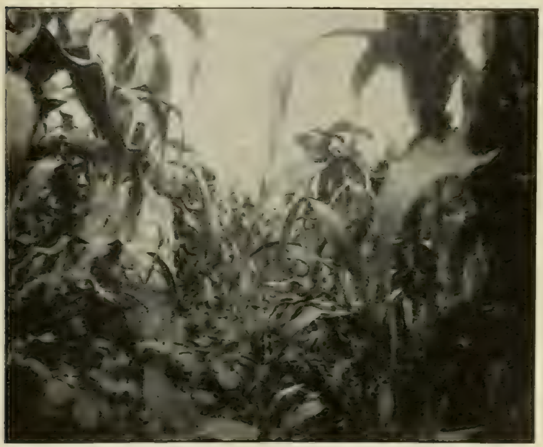

FIG. 56.— *Near view in a field of corn and soy beans, August 5, 1909. Corn was omitted from every third row*

A farmer in Madison county has grown corn and beans on the same land for a number of years and his soil is thoroughly inoculated with soy bean root-tubercle bacteria. His corn and soy beans are planted in check rows that are 3 feet apart one way and 2½ feet apart the other way. Viewing the field from the direction of the narrower rows, there are two rows containing hills of mixed corn and soy beans. Every third row grows hills of beans only. This rotation is repeated throughout the field. The corn and bean hills are planted with 5 or 6 kernels of corn and 8 to 12 beans. The hills of pure beans have 12 soy beans planted in each. In harvesting, the corn binder is run in the direction of the wider rows, mixing the hills of pure beans with those of corn and beans in the bundles. The soil used for this crop is capable of yields of 24 tons of corn fodder an acre. Weighings were made in the presence of Professor J. L. Stone, of the Cornell University Agricultural Experiment Station, in 1909. These weighings showed that the complete mixture of corn and soy beans grown by this method was yielding at the rate of nearly 22¾ tons of fodder an acre, which was 19 per cent soy beans. Weighings from rows that grew mixed hills of corn and soy beans showed a yield of 27 tons an acre, of which 11½ per cent was soy beans. By omitting the corn from every third row, the total yield of fodder was reduced but the proportion of soy bean fodder to corn fodder was increased over that obtained where corn and soy beans were planted in every hill.

In each of the foregoing instances, very good results have been obtained from feeding the soy-bean-and-corn ensilage to cattle. Concentrated feed has been saved and the milk flow maintained, or the animals fed have shown unusually good gains in flesh and in condition.

Another method of planting has been reported by a few farmers. It has not been successful except under favorable conditions. The corn is planted early in check rows. As soon as it is large enough, it is cultivated one way. Then soy beans are planted between the corn hills or even very close to them with a hand planter, crosswise of the first cultivation. All subsequent cultivating must be done between the rows of corn and bean hills. If moisture is abundant and the soil is in good physical condition, the beans grow to maturity. In many cases the beans are a failure, owing to the more advanced growth of the corn or to dry weather after planting. In Cayuga county a successful trial of this method resulted

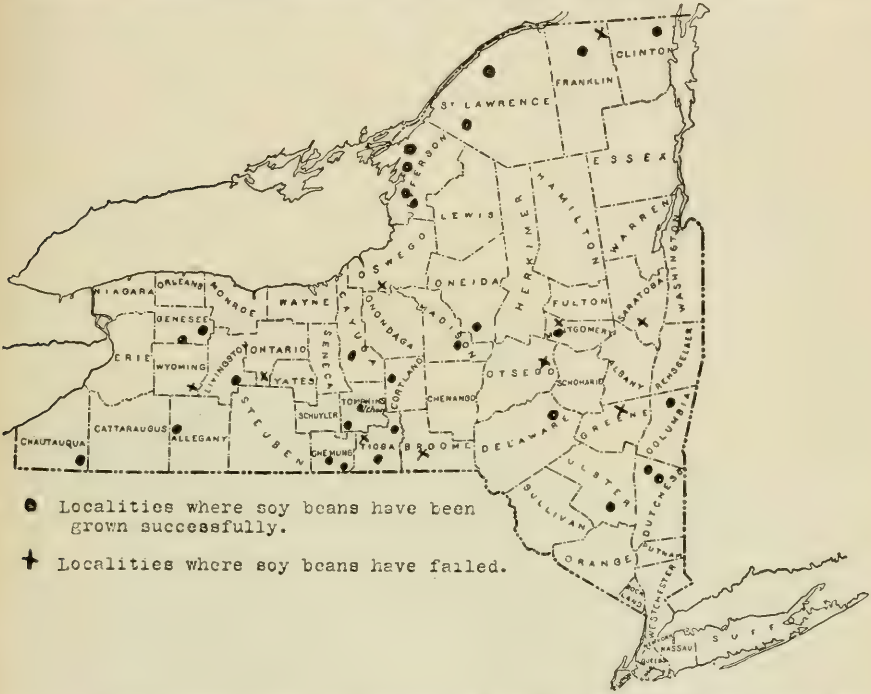

Fig. 57.— *Map showing some of the localities in New York where soy bean culture has been tried*

in the production of a mixed fodder containing about $\frac{1}{9}$ soy bean plants when harvested. The grower stated that the yield of corn fodder was apparently reduced somewhat where the soy beans were planted between the hills. The beans made an excellent growth, but no tubercles were found on the roots. No weights were reported and the work was not supervised by the College of Agriculture.

COOPERATIVE EXPERIMENTS

During three successive seasons, cooperative experiments with soy beans grown in cornfields have been made by farmers in different parts of the State. The College of Agriculture furnished the soy bean seed and directed that it be planted with the usual amount of corn on a part of the experimenter's cornfield. Weighings from $\frac{1}{100}$ acre or more of corn grown without soy beans, and of the mixed corn and soy bean fodder, were to be made at harvest time. The proportion of soy bean fodder in the mixture was to be determined by separation and weighing, also. The same plan was followed for two years, 1908 and 1909. During both years only a part of the experimenters were able to report results that were comparable. Others reported failure or partial success owing to a variety of causes. A tabulated comparison of results follows:

Locality, New York	Per cent soy beans in mixed fodder	Per cent increase or decrease of mixed fodder over corn grown alone	Per cent apparent increase or decrease in growth of corn due to mixture	Inoculation
1908				
Depauville	6.	—2.	—7.9	yes
Le Roy	11.	—17.	—26.1	no
Frewsburg	11.	+3.25	—8.	yes
1909				
Castile	.6	+.6	0.	no
Linden	6.3	+8.	+.9	yes
Malone	13.	+4.	—10.2	yes
Depauville	24.4	—6.	—29.	no
Madrid	26.9	+29.21	—5.8	no
Mean	12.4	+2.5	—10.76	

The cooperative experiments in 1910 were similar as to method of planting and cultivation, but $\frac{1}{10}$-acre plats were used. All the experimenters were provided with a commercial culture of root-tubercle bacteria adapted to soy beans for inoculating the seed. Only four complete reports were received. The results, tabulated in the same manner as those of the previous experiments, are as follows:

Locality, New York *1910*	Per cent soy beans in mixed fodder	Per cent increase or decrease of mixed fodder over corn grown alone	Per cent apparent increase or decrease in growth of corn due to mixture	Inoculation
Adams Center	17.	+11.6	—7.5	yes
Berkshire	20.	+15.7	—7.4	yes
Newfield	19.	—17.2	—33.2	yes
Malone	25.	—24.1	—43.1	yes
Mean	20.25	—3.5	—22.8	....

A large number of trials such as these are needed before satisfactory deductions can be made. Failure to plant the usual amount of corn when corn and soy beans are mixed has been one reason for the low yield of mixed fodder in a few cases. In the Le Roy experiment the results obtained indicated lack of uniformity in soil fertility where the different weighings were made. The variations in the percentage of soy bean plants found in the mixed fodder are partly attributable to the lack of a full

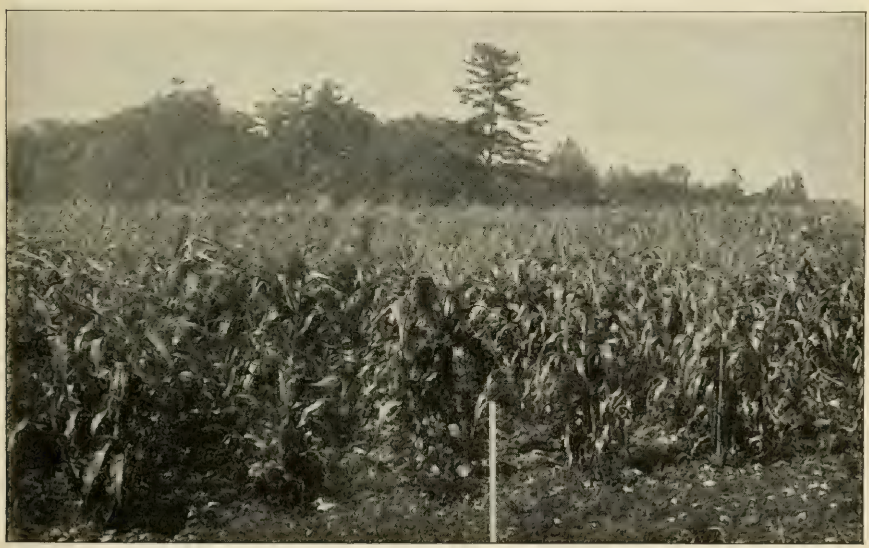

FIG. 58.—*On the left are rows of mixed corn and soy beans. On the right are rows of corn only. Season of 1909*

stand of corn plants, and partly to the differences in the varieties of corn with which the beans were grown. Since but one experiment shows an apparent increase in the growth of corn with which beans were mixed over that which grew alone, it can be said that generally the addition of beans to the corn hill or row tends to decrease the weight of the corn fodder produced. With the usual stand of corn plants to which beans are added, this reduction is not a serious disadvantage because the additional fodder produced in the soy bean plants and the superior quality of the mixed fodder will more than outweigh the loss. Of the twelve experiments five show an actual decrease in yield of fodder where soy beans were mixed with corn. The variations in decrease and increase of production are similar and almost neutralize each other when the mean of all (+.5 per cent) is taken.

EXPERIMENTS ON THE UNIVERSITY FARM

During three successive years, experiments, paralleling those just mentioned, were made on the Cornell University farm. Mixed corn and soy beans were planted in part of a cornfield each year. In 1908 and 1910 no inoculating material was used. In 1909 a culture of root-tubercle bacteria adapted to soy beans was used to inoculate the beans. An abundance of the tubercles formed on the roots close to the stem. (Where soil inoculation is practiced, tubercles occur anywhere on the roots of soy beans.) The weights by which comparisons were made were taken from areas of $\frac{3}{10}$ to 1 acre. Samples of the fodder produced on each plat were analyzed in order to compare the quality of the fodders produced. Pride of the North dent corn and Medium Green soy beans were used each year for the experiment. The mixed seed was planted with a two-row horse-drawn planter, which was adjusted to drop small hills of seed spaced 10 inches apart. The distribution of seed in the row was very much like that obtained by drilling continuously. In 1908 the soy bean seed was inferior and a thin stand of the plants came up in a normal stand of corn. The plat from which pure corn was weighed that year was not contiguous to the plat that grew the mixed fodder, but was located in the same field. The difference in yields of fodder between the two plats is probably due partly to differences in soil fertility. The results are shown herewith:

Kind of Fodder	Yield	Per Cent					
	Tons	Water	Protein	Ether extract	Carbohydrates	Crude fiber	Ash
Corn only, 1908	20.35	78.72	2.26	.58	13.03	3.83	1.58
Corn only, 1909	6.90	72.88	2.48	.85	16.96	5.40	1.43
Corn only, 1910	7.23	67.49	3.06	1.13	21.75	5.25	1.32
Corn and soy beans, 1908	16.27	78.00	3.27	1.01	11.56	4.50	1.66
Corn and soy beans, 1909	6.43	73.12	2.68	.90	16.81	4.94	1.55
Corn and soy beans, 1910	7.77	67.56	2.95	1.37	21.00	5.80	1.32
Corn, average for three years	11.49	73.03	2.60	.85	17.25	4.83	1.44
Corn and soy beans, average for three years	10.16	72.89	2.97	1.09	16.46	5.08	1.51

The results obtained in these trials have not been very encouraging. The fields in which the corn grew in 1909 and 1910 were not well adapted to corn, and the seasons were too cool and too dry for good corn-growing. The advantage of soy-bean-and-corn fodder in composition seems slight, and in average yield the advantage is with corn alone. A separation of the bean plants from some bundles of the mixed fodder in 1909 indicated 6 per cent of bean fodder in the mixture. It was lower, rather than higher, in the other two years. The mixture has not proven a success on the university farm when grown in that manner.

In 1911 equal quantities of soy beans and corn were mixed and planted in check rows about May 12. Hand planters were used to drop the seed. The beans came up and flourished with the corn in a few favored parts of the field. The stand of corn varied from 0 to 5 stalks per hill, owing to the varying proportion of corn kernels and soy beans dropped in each hill. On another part of the field where the corn had made a good stand, soy beans were planted by hand between the hills after the first cultivation. A total failure of the beans resulted. They had no chance in competition with the corn under such a handicap.

The writer has failed to prove the real value of soy beans grown in cornfields for silage in the experiments just described. It therefore seems desirable to quote from signed statements by our correspondents in regard to their success with the mixed crop. The names of these correspondents are withheld out of consideration for them. Any reader desiring to communicate with certain of them should write for their names to the author of this bulletin.

A florist at Hamilton, N. Y., who owns a farm that is occupied by a tenant, writes:

"As to varieties, we use the Early Green as the others will not mature here. We formerly used the Leaming and Pride of the North corn but now are using Iowa Gold Mine. I row the corn both ways and after planting the corn go over the ground and plant the beans in the same hill with a jab planter. So far we have only used it on part of our field. * * * Our soil is a clayey loam with a clayey subsoil. The beans will grow equally well on a gravelly soil. We fit the land for corn with stable manure and when planting the corn use a little phosphate, then jab the beans in the same hill.

"The beans serve a fourfold purpose. First, they smother the weeds that get into the hill with the manure. Second, * * * they absorb nitrogen from the air and the corn gets the benefit the same year. I have seen in our fields a difference of several inches in growth in favor of the corn with the beans over pure corn all through the season. Third, it is of great benefit to the ensilage in the silo. * * * While I am not prepared to say it is a balanced ration, it will, when properly grown, reduce the grain bill from one half to two thirds. Fourth, I get practically two crops per acre and the soil left in better condition.

"We filled our 15 x 30 silo from six acres while our neighbors required nearer ten of pure corn. I firmly believe that soy beans grown with all the silage corn, and alfalfa for hay, will solve the feed problem for the farmer to a very great extent."

On being asked if he continued to practice growing soy beans with corn for silage, a dairy farmer at Elmira wrote:

"I certainly have continued the practice * * * and think I shall * * * as long as I keep a dairy unless I find something which excels it. We raised about 20 acres of corn for silage this year and have two large silos full. I have my corn and beans mixed before planting, 6 quarts of beans to 1 bushel of corn. This gives a good balanced ration. I find the Medium Green soy bean the most satisfactory of any of the 13 different varieties I have tried as they mature about even with the corn. We obtained a growth of from 3 to 4½ feet in height. * * *

"Before I commenced feeding my silage this fall we were feeding quite heavy of brewers' grains but now have reduced them one half and the cows hold their flow of milk as well as before. I never found anything that equals the corn and bean silage. * * * We never have made the butter nor had our cows come out so well in the spring as they do on this silage."

One of the Millbrook, N. Y., growers of soy beans and corn ensilage writes:

"We have very satisfactory results from feeding our silage mixture; cows, steers, and sheep doing nicely on it. I am not sure just how much more feeding value the soy beans give it. Last winter I fed ten steers with silage, shredded corn stalks, and a little mixed hay. During the last month they had ½ ton of cottonseed meal. From September, 1910, to May, 1911, they made a gain of 500 lbs. each and were fat and very sleek.

"We do not find it necessary to feed very much grain to our milking cows to get a good flow of milk and have them in good condition when eating plenty of silage."

From Hobart, N. Y., a farmer writes that his crop of mixed corn and beans did not come up well, but the soy beans grew about 3 or 3½ feet high and were well filled with pods. He states that his cows have shrunken in milk flow since he finished feeding the beans.

A farmer near Lowman, N. Y., has raised corn and soy beans mixed for two seasons. He writes: "I like the Medium Green soy beans best as they get a better growth and harvest better with the corn." Last winter one of his cows, eight years old, gave forty-four pounds of milk a day, eating eight pounds a day of grain with soy bean and corn silage. The preceding winter she gave forty pounds of milk daily while eating ten pounds of grain. The addition of soy beans to the silage made a saving of two pounds of grain and a gain of four pounds of milk daily.

An enterprising farmer at Gouverneur writes: "After writing the company that made our corn planter and they telling me that they did not think I could plant soy beans and corn for silage at the same time, I did some thinking and got them to make some special plates to go into the fertilizer box. With such plates we planted our corn and soy beans at the same time. They came up together and the soys grew from 2½ to 4 feet high and in no way interfered with the corn in cultivating, harvesting, silage cutting, or in handling, and they went into the silo together. We had a great growth of vines but no grain in the soy beans, for they were of a very late variety. * * * We took the harvester to the field and fed out green about 1½ acres and the milk cows would greedily pick out the soy beans first and then go for the corn. We plant corn for the grain in silage and it gets ripe enough for good silage."

From Cuba, N. Y., a young farmer writes: "We planted soy beans in all our ensilage corn this year and they grew very well, being well podded and nearly ripe by the time the corn was ready for the silo. We mixed about 1 bean to 2 kernels of corn, planting in hills 3 feet apart each way. Our farm is nearly all gravelly loam, a very good corn soil. We think the soy beans add much value to the ensilage on account of their protein content. We procured some seed of the Medium Green variety last year and planted two rows 25 rods long. They produced a bushel of beans, which we used this year in the corn, without inoculation of any kind."

A farmer near Hobart, N. Y., relates his first experience with the mixed crop thus: "I used an artificial culture for inoculating the soy beans. I mixed four quarts of the beans with twelve quarts of Pride of the North corn and sowed on one acre with a grain drill. The soil was low-land gravel soil with gravel subsoil. The beans grew about 3½ feet high, very luxuriant, and were filling nicely when the frost came. * * * I got as much corn as I would had the beans not been there, so of whatever value the beans may be I consider it clear gain."

The proprietors of a farm near Hamilton, N. Y., write: "Our method is to plant the corn in hills rowed both ways 40 inches apart and planted with a check row planter having phosphate attachment. Then with a stab planter put about 5 beans in each hill, cultivating the same as though the beans were not there. * * * Our soil is Dunkirk gravelly loam. Our yield is about 15 tons per acre. * * * We would not know how to get along without ensilage but as we have planted soy beans ever since we built a silo we are not prepared to make a statement on the relative value of corn silage with and without soy beans."

DESIRABILITY OF FURTHER EXPERIMENTS

In order to introduce soy beans to localities where conditions are favorable for their growth, and to further demonstrate their value as a supplementary ensilage crop, we desire to continue the cooperative experiments. We hope to conduct these experiments in such a way that the value of soy beans mixed with corn, or grown alone for green forage or for seed production, will be thoroughly tested. Persons who are interested in growing forage with a higher protein content should write to us asking for detailed instructions about these experiments. Since the seed of the Medium Green variety is scarce and the price relatively high, there seems to be an opportunity for profitable seed production at the present time

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FEBRUARY, 1912 BULLETIN 311

CORNELL UNIVERSITY

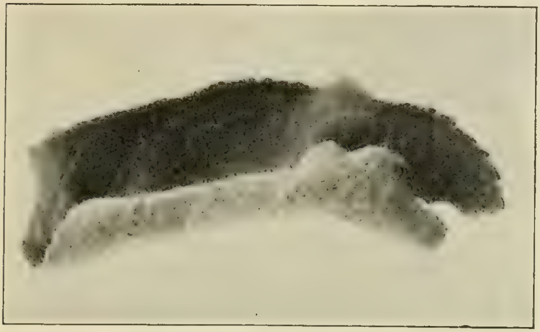
AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Entomology

THE FRUIT-TREE LEAF-ROLLER

With Notes on Allied Forms



By GLENN W. HERRICK

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THE FRUIT-TREE LEAF-ROLLER

Archips argyrospila

Order, *Lepidoptera* Superfamily, *Tortricina*

Glenn W. Herrick

In his eleventh report, 1896, Dr. J. A. Lintner gave a list of 356 species of insects that were enemies to the apple. Many of these, in fact the majority, are not serious enemies. However, each one is known to make the apple tree and its fruit, at times, its food by choice and one can never tell when the least injurious species may suddenly become a most serious pest. In this list of Doctor Lintner's, the fruit-tree leaf-roller (Fig. 59), a relatively unimportant pest at that time in New York, was included. Fifteen years have elapsed since the list was made, and during that time nothing was heard of the leaf-roller until in 1911, when it suddenly came into prominence as a serious pest to apples and a minor one to pears. It furnishes simply another instance in which an insect, previously unimportant, suddenly and inexplicably multiplies to an enormous degree and reaches the rank of a serious pest at a single bound.

For many years the growers of Colorado, Missouri, and other western States have had to contend with this leaf-roller, but until very recently the eastern growers have been comparatively free from its ravages. The adult moths have been collected from Maine to California, but evidently they have never been abundant in the extreme East. In the spring of 1911, however, the larvæ of this species appeared in enormous numbers in the orchards of W. O. Page at Bethany Center, N. Y., and to a considerable extent in neighboring orchards. In the orchards of Mr. Page they proved a very serious pest. Moreover, the apple leaf-roller was not confined by any means to a small and limited area, but the larvæ were found in many orchards of New York in varying numbers. Whether or not this thin, but rather wide, distribution among the apple orchards of the State means a general and rapid increase of the pest, remains to be seen; it is quite probable, however, that the insect has become rather thoroughly established and will develop into a gradually increasing and troublesome pest.

HISTORY OF THE FRUIT-TREE LEAF-ROLLER

So far as the writer has been able to find, the first reference to this leaf-roller as a pest of economic importance in this country was made by

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Author's acknowledgments. — Thanks are due Harry Knight for his aid in making some of the photographs in this bulletin, and for his assistance in the rearing of the ugly-nest leaf-roller; to H. L. Viereck for his determination of parasites; and to R. W. Braucher for sending the writer material from the field.
Glenn W. Herrick.

Dr. A. S. Packard in 1869. He discusses it as a cherry pest and states that it has been raised in abundance from that fruit tree. In 1880 Doctor Packard again refers to it as an enemy of the oak, and remarks that, as Dr. C. V. Riley has reared it from hickory, oak, soft maple, and elm, it must be a general feeder on shade trees.

In 1890 Professor Gillette recorded it as a serious pest to apple and cherry trees in Colorado, and found that it completely defoliated the trees in some instances. He also records it as attacking the plum, currant, raspberry, and gooseberry bushes. During the next few years it gradually increased in numbers, so that by 1894, he says, it was very abundant on all kinds of fruit trees, and a large proportion of the fruit trees in the northern part of the State were completely defoliated by the latter part of June. In 1896 Gillette listed it among the worst insect pests of Colorado, although it had evidently decreased somewhat by that time. In 1904, however, it again became very abundant, for he records this leaf-roller as very destructive to the foliage of fruit trees in Denver and in the vicinity of Colorado Springs.

In the following year (1905) the leaf-roller became very destructive in Missouri and was reported as injurious from every county in the State. Professor Stedman writes that it greatly injured cherry, plum, apple, pear, and apricot trees. His correspondents wrote that in some orchards 75 per cent of the crop was destroyed, while in others the crop was " entirely ruined."

The first definite reference to the occurrence of this leaf-roller as a pest in New York was that made by Doctor Lintner in 1888, although he had collected the adult moths as early as 1874. In June of 1888 he received the larvæ of this insect from P. Barry, of Rochester, N. Y., who had found them eating into young pears. Again, in 1892, Doctor Lintner received some young apples that had been deeply pitted. This injury he refers doubtfully to larvæ of the leaf-roller. From that year to 1911 we hear nothing more of this pest in New York.

The leaf-roller is evidently one of those insects that fluctuate markedly in numbers and in destructiveness. It appears to be exceedingly abundant and destructive some years, and then gradually to decrease for several years only to rise again into another period of great abundance. During the past season it has again been very abundant in the Western States and has caused a great amount of loss. Moreover, the outlook for next year is causing the growers considerable anxiety. Reports from Colorado are to the effect that the trees in some orchards are covered to the tips of the branches with eggs, and the prospects are grave for even more severe injury next year. In certain localities in New York the leaf-roller promises to be present in abundance next year.

THE NAME

Nearly fifty years ago Francis Walker, a noted English authority on moths and butterflies, described and named the fruit-tree leaf-roller. It had evidently been collected in Georgia and finally deposited in the British Museum. Walker gave it the specific name of *argyrospila*, which means "silver-haired" and probably refers to the silvery spots on the front wings. Six years later it was described as a new species by C. T. Robinson, from specimens collected in New York and in Massachusetts. He placed it in the genus *Tortrix*, under the specific name *furvana*. In the same year Doctor Packard described the moth under the name *Tortrix V-signata*, or the V-marked tortrix. Finally, the insect was placed by Walsingham in the genus *Cacœcia* where it remained until 1902, when Doctor Fernald, in Dyar's Catalogue of the Lepidoptera, placed it in the genus *Archips* where it still reposes.

It has been given the common name of fruit-tree leaf-roller because of its habit of rolling the leaves of the trees that it infests. There are other moths of the same genus, however, which infest fruit trees and roll the leaves; so that this common name is not very distinctive. Perhaps Doctor Packard's name, "the V-marked leaf-roller," or perhaps the name "silver-winged leaf-roller," would be more appropriate and distinctive.

The following synonymy shows the history of the species in regard to its scientific names:

1863 *Retinia argyrospila* Walk., Cat. Lep. Brit. Mus., XXVIII, p. 373.
1869 *Tortrix furvana* Rob., Trans. Amer. Ent. Soc., Vol. II, p. 265, Plate I, Fig. 9.
1869 *Tortrix V-signata* Pack., 17th Rpt. Mass. Bd. Agri., p. 238.
1875 *Tortrix* (*Loxotœnia*) *furvana* Zell., Verh. Zool-bot. Ges. Wien, XXV, p. 13.
1879 *Cacœcia argyrospila* Wals., Ills. Typical Specimens of Lep. Het. Brit. Mus. N. A. Tortricidæ.
1902 *Archips argyrospila* (Walk.), Dyar's List of N. A. Lep., p. 480.

DISTRIBUTION AND FOOD PLANTS

Dyar gives the insect's distribution as the northern United States, California, and Colorado. It has been taken, however, in Georgia and reported as fairly common in Maine and Massachusetts. Packard says that "it ranged from Maine, where it is common, to Georgia, Texas, and Missouri, while it is not uncommon on the Pacific coast." It is undoubtedly widely distributed throughout the United States, but is probably more abundant in the northern part.

In New York State we have found this leaf-roller present and committing injury in Niagara, Orleans, Wayne, and Genesee counties. In addition, Doctor Felt reports a species of *Cacœcia* as abundant in an orchard in the Hudson River valley. Very likely it is the species under discussion, although Doctor Felt did not rear the moths. Unquestionably the leaf-roller is widely distributed in this State.

We have found the larvæ feeding on a wide variety of plants. We have bred the moth from larvæ on the apple, pear, sweet cherry, wild cherry, black walnut, and mountain ash. At Bethany Center we found the larvæ abundant on plum, pear, quince, apple, and cherry trees. Gillette records it on apple, plum, cherry, honey locust, rose, currant, gooseberry, and a species of *Circocarpa* known as " deer-bush."

As already pointed out, Dr. C. V. Riley bred the leaf-roller from rose, apple, hickory, oak, soft maple, elm, and cherry. Packard records it on oak, black walnut, maple, cherry, and California horse-chestnut. In addition, Stedman finds it on apricot, osage orange, box elder, sassafras, and hazelnut.

The larva of *A. argyrospila* is very similar to that of *A. rosaceana*, and one is likely to confuse the two species in a superficial examination. The only safe way to determine the host plant is to breed the adults.

HABITS AND INJURIES

The larvæ appear as the buds are bursting, and begin to attack the unfolding leaves. They bend the leaves over and tie them together with silk (Fig. 67). Within this sort of nest the larvæ live and eat the leaves. As soon as the blooms appear the larvæ begin to eat off the blossom stems and tie them together with silken threads, along with the leaves surrounding the blossom cluster. This webbing and tying together of the blossom clusters is a most pernicious habit because it interferes seriously with spraying for the codling moth. In one Baldwin orchard in which the larvæ were very abundant, the blossom clusters were so webbed together and covered over with silk, dried petals, and leaves that it was almost impossible to get the spray mixture into the calyx cup. As soon as the young apples or pears begin to set they are tied together with silk, while the larvæ live inside and gnaw cavities into the sides of the young fruit (Figs. 64, 65, 68). Doctor Lintner reports the same habit of the larvæ and refers to some young pears that were eaten into, sent to him by P. Barry, of Rochester, in 1888. Stedman mentions the same kind of injury in Missouri and considers this the most serious form of injury committed by the insect. It is certain that in New York orchards during the past season a very large number of pears and apples were totally destroyed by the larvæ, and many others were seriously marred and deformed. To give some idea of the number of larvæ present, the writer counted 17 worms in nine blossom clusters; Braucher counted 21 larvæ on one twig 21 inches long, and 19 larvæ on another twig 22 inches long.

The larvæ also work on the leaves, rolling them and living within the roll. Here, effectually hidden, they feed on the tender tissues of the leaves.

When disturbed, they drop down out of their hiding places and remain suspended by silken threads like cankerworms. When all is quiet, they climb back to their hiding places and begin their work again. Their injuries to the leaves are often very serious, especially when the larvæ are abundant. Gillette says, " I have seen small orchards entirely defoliated by this species so that not a green leaf could be seen."

LIFE HISTORY

The number of broods.— Packard observed the caterpillars feeding on the oak early in June and found the moths appearing the latter part of the same month, and therefore inferred a second brood of larvæ. He says: " Hence without much doubt there are two broods, the caterpillars occurring late in summer turning to chrysalids, and hibernating as such, the moth flying about in the spring and laying its eggs on the shoots, so that the larva may hatch when the leaves are unfolding and find its food ready at hand."

Gillette says that he finds only one brood a season in Colorado. The eggs, which are deposited in July, remain unhatched until the following spring. Stedman says, " There is, in Missouri at least, only one brood of this insect each year."

Our observations accord with these and we find only one generation each year in New York. We have many batches of eggs now in the cold house lying over until next spring, and there are many thousands of them on the apple trees. The fruit-tree leaf-roller undoubtedly passes the winter, in New York State, only in the egg stage. Further, it would seem as though one generation a year was the normal habit of the insect.

The eggs.— The eggs are laid by the moths in June, the major number during the middle days of this month. We have a definite record of the eggs being deposited in our cages on June 12. They remain on the trees until the following May, or over ten months. The eggs are deposited in small oval, convex patches (Figs. 60, 63) on the bark of the smaller twigs. In searching for them in the orchards we very often find them laid on the rough fruit spurs of the apple, where it is almost impossible to see them. The masses are usually a shade darker green than the branches, but often there is very little difference. The eggs are placed very closely together in the mass and covered with a heavy varnish, so that it is difficult to distinguish the individual eggs. In one batch about average in size the writer counted 110 eggs; other masses certainly contained more, and still others much less. The masses vary in size from that of the end of a lead pencil, and smaller, to twice that size.

Unfortunately, no data are at hand regarding the number of eggs deposited by a single moth, but Fig. 71 shows four clusters undoubtedly deposited by a single female. Sanderson found that a closely related species, *A. rosaceana*, laid 45 to 650 eggs with an average of 305 to a single moth.

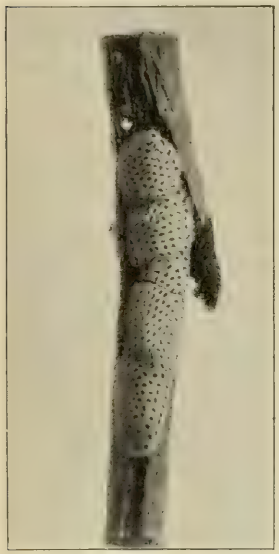

FIG. 71.—*Egg patches deposited by a single female*

Our records show that the eggs hatched in the spring of 1911 from May 4 to May 7. R. W. Braucher found the eggs hatching in the field in abundance on May 9. There would probably be some variation in the time of hatching from season to season, depending on the backwardness or earliness of the spring. Stedman says that they hatch in Missouri in the latter part of April and the first part of May. Gillette finds that in Colorado they hatch in the latter part of April and in time to begin feeding on the very young leaves. Sometimes they appear on cherries early enough to damage the buds considerably before the latter burst.

The caterpillar.— The caterpillars gnaw through the thick coat of varnish over the eggs, leaving the mass full of tiny holes and of a light gray color. The empty egg masses (Fig. 72) are very conspicuous because of their light color. Our observations show that all the caterpillars of a single egg mass emerge about the same time.

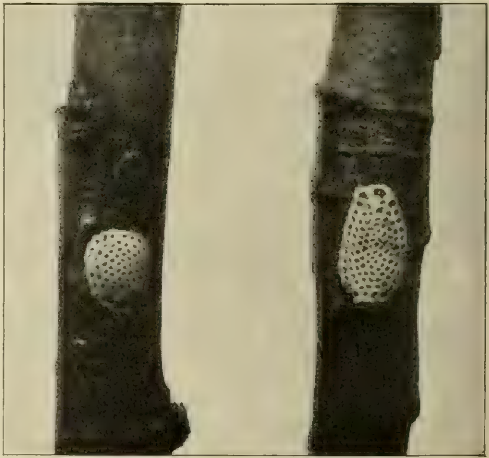

FIG. 72.—*Empty egg masses*

The young larva is about one twenty-fifth of an inch long, light green in color, with a very large black head and a wide, dark-colored prothorax. The body is sparsely covered with long, slender hairs somewhat noticeable along the sides. When full grown, the caterpillars measure from seven eighths of an inch to practically one inch in length. The mature larvæ (Figs. 61, 66) vary considerably in

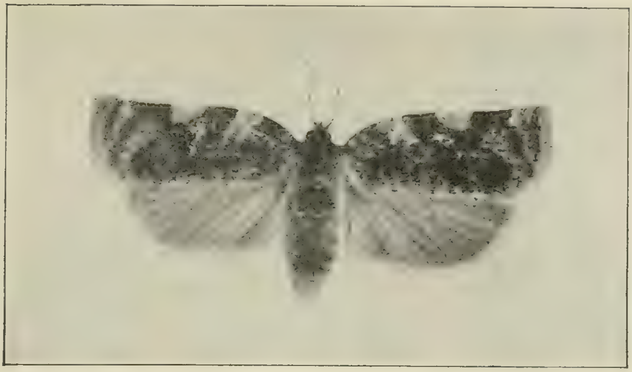

FIG. 59.—*Moth*

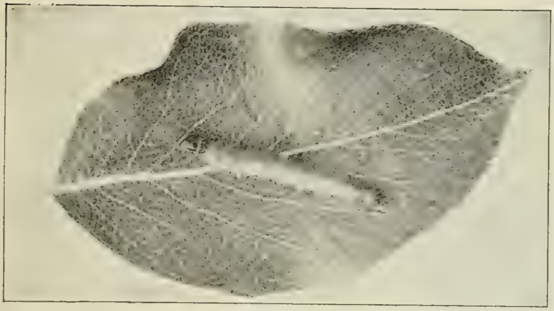

FIG. 61.—*Larva on leaf*

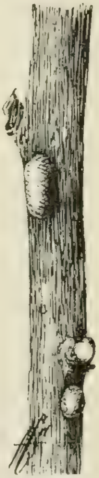

FIG. 60.—*Egg patches*

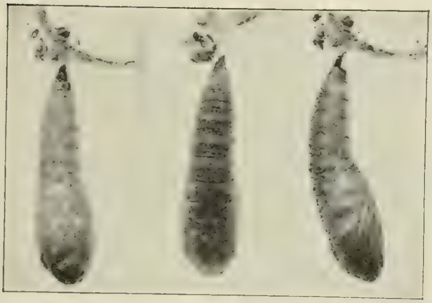

FIG. 62.—*Pupæ*

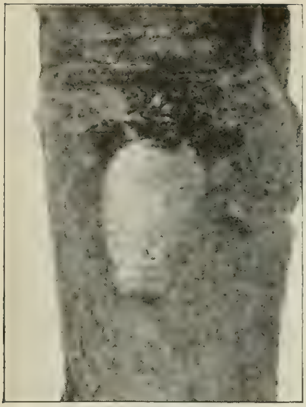

FIG. 63.—*Patch of eggs*

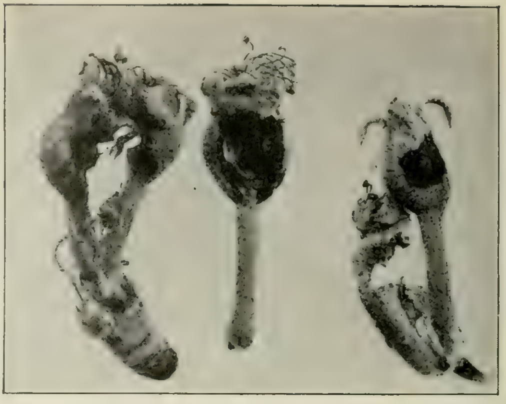

FIG. 65.—*Work of larvæ on apples*

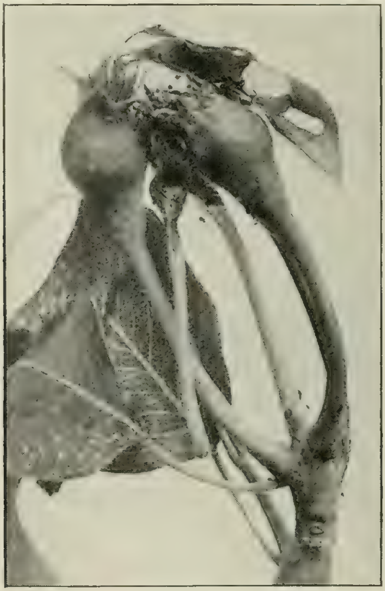

FIG. 64.—*Work of larvæ on pears*

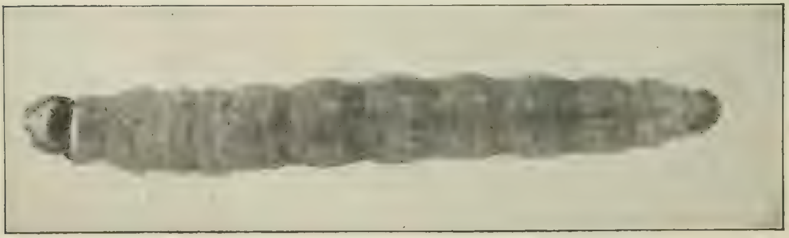

FIG. 66.—*Larva much enlarged*

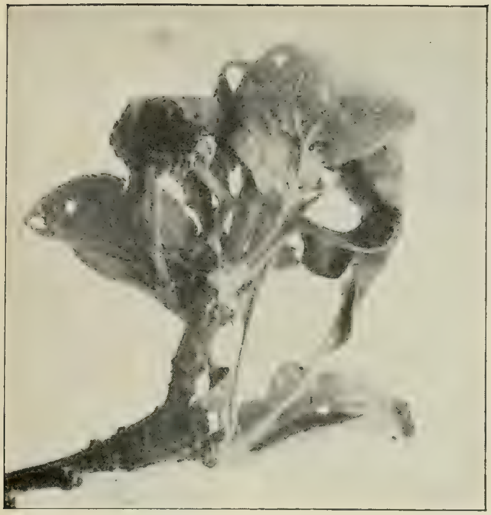

FIG. 67.—*Work of larvæ in tying leaves together*

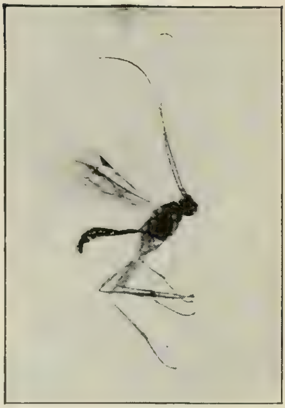

FIG. 69.—*A parasite, Amicroplus sp.*

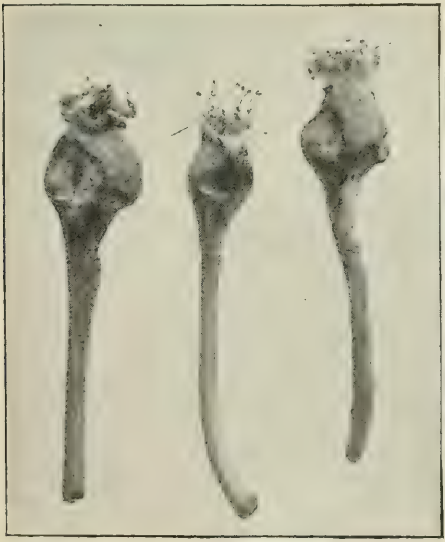

FIG. 68.—*Work of larvæ on pears*

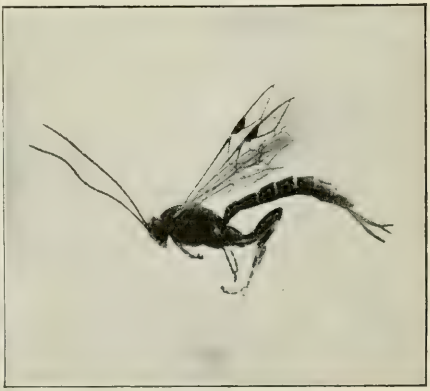

FIG. 70.—*A parasite, Pimpla conquisitor*

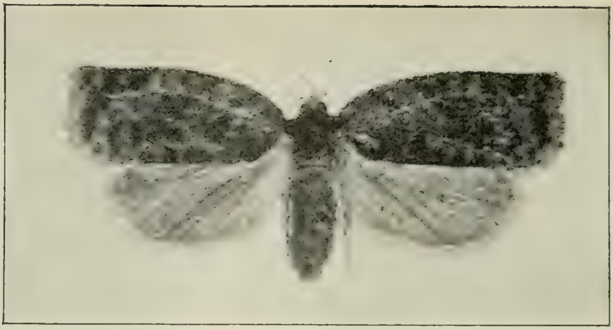

FIG. 73.—*Moth of the ugly-nest leaf-roller*

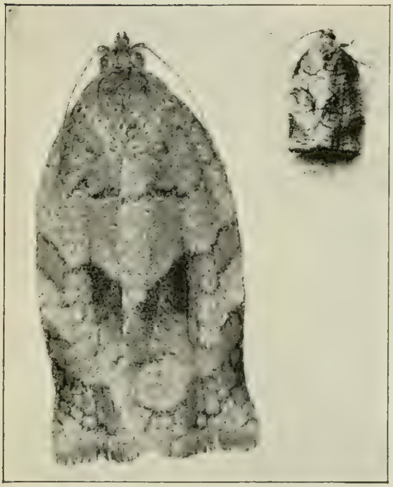

FIG. 74.—*The oblique-banded leaf-roller*

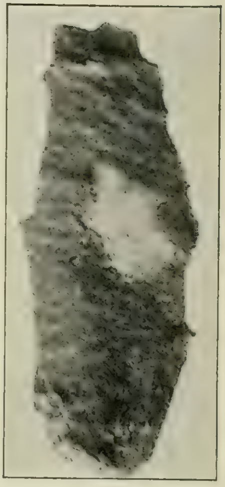

FIG. 75.—*Eggs of the oblique-banded leaf-roller*

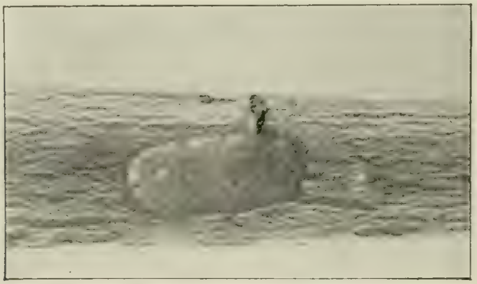

FIG. 77.—*Eggs of the ugly-nest leaf-roller*

appearance. In general, we find the body light green in color, the head black, and the thoracic shield dark-colored, at least up to the last molt. The thoracic shield varies, for in some individuals it is light brown on top and marked along each edge. Dyar, in descriptions of these larvæ collected in Colorado, calls attention to the great variation and describes in detail several varying individuals. He also describes one lot of larvæ as *C. vividana*, but states that it is not more than a variety of *argyrospila.*

In our cages in the insectary, the shortest period in which the larvæ matured was 22 days; some took considerably longer to mature. Gillette, in Colorado, placed egg masses in sacks tied over the limbs of plum trees and found that the shortest time for a larva to mature was 30 days. It is possible that a scarcity of food prolonged the time in this case. On the other hand, if the food is allowed to become scarce when the larvæ are nearly mature it will hasten pupation, and perhaps this was the case in our cages, although Stedman says that in Missouri they mature in 18 to 20 days. Sanderson and Jackson found that the larvæ of *A. rosaccana* matured in 22 to 46 days. No doubt there is an equal amount of variation among the larvæ of *argyrospila.*

The pupa.— When the larva becomes full-grown it spins a very thin, flimsy web in a rolled leaf, or between the leaves that are tied together, and changes to a pupa. The pupa is light brown, and usually a little over half an inch long. It is a very active pupa, wriggling vigorously when handled. There are two transverse rows of backward projecting hooks on the top side of most of the abdominal segments. The last segment of the abdomen is considerably longer than the others, is tapering, and ends in about six strong chitinous hooks (Fig. 62).

In the cages in the insectary the pupal stage lasted nine to twelve days. Gillette found that in Colorado the pupal stage averaged, out of doors, about eleven days.

The moth.— In general the moth is rusty red with two bright silvery spots along the costal margins of the front wings (Fig. 59). The moths vary from three quarters of an inch to an inch in expanse of wings. The males are usually smaller than the females. There is a marked variation in the coloring and markings of the moths; some are much darker than others, and in some the markings are very distinct while in others they are not.

Our records during the season of 1911 show that the moths were emerging nearly every day from June 5 to June 21, with the latest moth appearing June 24. Mr. Braucher, who was in the field working on the codling moth, reports that on June 13 the moths were out in very great numbers. It is evident that by the middle of June the moths were emerging in greatest numbers and that they were almost entirely out before July.

NATURAL ENEMIES

The fruit-tree leaf-roller seems to have a number of natural enemies, mostly hymenopterous parasites. We bred at least four species from the larvæ and pupæ in our cages. In the field Mr. Braucher became much interested in the parasites of this insect and bred many primary and secondary parasites and at least one tertiary parasite. The whole problem is a complicated and interesting one and needs much more detailed study before it is finally cleared up.

It seemed at first, from the great number of parasites issuing, that the pest would be almost exterminated. As a matter of fact, the parasites seemed to have little effect in diminishing the number of emerging moths. Either the caterpillars of the *Archips* were too abundant to be sensibly lessened in numbers, or the secondary parasites succeeded in preventing the primary ones from becoming effective. The latter theory, however, is hardly probable because there was time for only one generation, and whatever primary parasites were present probably accomplished their work before being killed by the secondaries. It is quite probable that we overestimated the number of individual parasites.

The parasite that was bred in greatest numbers was *Pimpla conquisitor* (Fig. 70). This parasite appeared in large numbers and must have destroyed many larvæ of the leaf-roller.

Another species parasitic on the larvæ was *Amicroplus* sp. (Fig. 69). Twenty-three specimens of this small parasite were bred from one larva. Their cocoons, spun on the outside of the body of the host, almost covered it.

We also reared a single specimen of *Phytodietus vulgaris* and a single specimen of *Sympiesus* sp.

Mr. Braucher reared, in addition, *Pimpla inquisitor* and *Glypta simplicipes*. These two species seemed to be quite abundant in the field. He also obtained a single specimen of *Carcelia nigropalpus*.

Notwithstanding this rather large list of parasites on one host, the leaf-roller was not held in check. The moths issued in abundance in spite of the parasites and deposited large numbers of eggs.

METHODS OF CONTROL

The leaf-roller has not proved an easy pest to control. The habit that it has of rolling leaves, tying them together, etc., and then living within these protective coverings, makes it a difficult insect to get at.

Recommendations have been made to crush the egg masses, at least all that can be found, during the winter when other work is not pressing. It seems to the writer that this is impracticable because the egg masses are so small and so like in color to the bark that they cannot be found with any degree of facility. It would take too much time and labor to prove at all economical.

On the other hand, in a severely infested orchard it might be entirely practicable and economical to prune the trees rather severely, especially those known to bear egg masses. Judicious pruning is a good orchard practice, anyhow. We found only the smaller branches, twigs, and fruit spurs bearing the eggs. When taken off, these should be promptly burned.

Gillette, of Colorado, has recommended the use of kerosene emulsion to destroy the eggs, and also a thorough coating of whitewash "upon the trunks and main limbs" to destroy the young larvæ as they are eating their way out of the eggshells. In his later experiments, however, he comes to the conclusion that whitewash and lime-sulfur and salt do not give much promise. During the coming season we hope to try the lime-sulfur wash applied as late as possible before the eggs hatch in the spring. It will be necessary to use liberal quantities of the wash and to drench the tree, so as to be certain of coating the egg masses on the smaller branches.

Gillette found that 33 per cent kerosene emulsion applied to the egg patches killed all the eggs. He says, "The application may be made any time after the leaves drop in the fall and before the buds begin to swell in the spring." During the season of 1895 he was able to control these leaf-rollers satisfactorily in the college orchard through an application to the trunks and the larger limbs, early in the season, of a strong kerosene emulsion, and by the use of paris green on the foliage later.

The miscible oils, if they do not injure the trees, would be much more convenient to apply than is the kerosene emulsion, and would probably be about as effective. We hope to determine these points during another season.

One would think that a good spraying of the infested trees with arsenate of lead added to lime-sulfur just before the buds break, and another before the blossoms open, would control the pest, but in this we were disappointed. The worst-infested orchard was sprayed once by the owner for the blister mite and bud moth, about as the buds were swelling. At this spraying 2 pounds of arsenate of lead were added to 50 gallons of the mixture. On May 9 Mr. Braucher, who was in the field at work on the codling moth, found that the leaf-rollers were hatching in abundance, and on May 13 he sprayed thirteen Baldwin trees, putting on 200 gallons of lime-sulfur mixture to which 8 pounds of arsenate of lead had been added. This was just before the blossoms opened. Later, after the petals had fallen, the regular codling-moth spraying was given, making three poison sprays applied to these infested trees. We were much disappointed to find that the larvæ were not visibly lessened in numbers by these applications.

It is just possible that the arsenate of lead in water alone, instead of in combination with lime-sulfur, would have been more effective. It is probable, however, that a stronger application of poison will be necessary in order to control this insect. Either more arsenate of lead will have to be applied, or a substance containing a greater percentage of arsenious oxid must be used. Something must be found that, when applied to the bursting buds, will be powerful enough to kill the young caterpillars even though they get very small quantities of the poison.

To sum up, then: (1) We would advise a thorough drenching of the trees with lime-sulfur at scale strengths for a dormant spraying to prevent the eggs from hatching, provided one is going to spray for the San José scale or the blister mite; we are not yet ready to recommend a spraying for the eggs of the leaf-roller alone. This application should be made as late as possible in the spring before the buds burst. (2) We would advise a thorough spraying with arsenate of lead at the rate of 2½ to 3 pounds to 50 gallons of water, before the buds burst but while they are swelling or just as the tips begin to show green, and again before the flower buds open. These applications will also catch the bud-moth larvæ, which are serious pests.

NOTES ON SOME CLOSELY ALLIED SPECIES

There are two closely allied species of moths that live on fruit trees and at times cause considerable injury. These were quite abundant during the past season, and we had opportunity to obtain some new facts regarding their life history and to make some new pictures of egg masses, adults, etc.

THE OBLIQUE-BANDED LEAF-ROLLER

(*Archips rosaceana*)

This species in particular has been abundant, and the larvæ are so much like those of *argyrospila* that one is easily mistaken for the other (Fig. 74). Moreover, it has the same habits of rolling the leaves of the apple and of eating into the sides of the young apples. It was present during the past season in many orchards in New York and was responsible for considerable injury. During the season of 1896 Doctor Lintner recorded this species as " quite abundant and destructive in apple orchards." It was sent to him from several places in eastern and central New York, with the report that it was very injurious " not only to the foliage, but later in the season to the young fruit, into which it ate rounded holes of considerable size, often extending to beyond their center." Fletcher has recorded injury to the foliage and the young fruit of pears in Ontario, and Piper writes that prunes in Washington were injured by the larvæ. Lugger, of Minnesota, also reports that apples in that State were sometimes defoliated by this leaf-roller. Evidently it is sometimes a serious pest to fruit trees.

Observations on the life history.— The life history of this species has never been fully worked out, for it is not known how the insect passes the winter. It has been surmised that the winter was passed in the egg stage; Sanderson and Jackson, however, conjecture that the winter is passed in the larval stage. They say, " From the fact that the larvæ occur in the fall and early spring and that many species of this family pass the winter as larvæ, it seems probable, though we have no definite observations on this point, that the larvæ hibernate over winter probably within folded leaves well encased in their own silk, either attached to the trees or on the ground, although they may hibernate under or attached to the bark."

Our observations show that there are two broods of the moths during a season and that the winter is passed in the egg stage, similar to *argyrospila* and *cerasivorana*. The eggs hatch early in the spring and the larvæ mature and the moths appear in June. Our records show that the eggs from these moths were hatching in our cages on June 28 and in the field on June 23 and 24. These larvæ matured and the first moths of the second brood appeared August 3. These moths, undoubtedly, like *cerasivorana*, lay eggs that pass the winter.

The eggs are laid in clusters on the bark and on the leaves of the trees. In Fig. 75 is shown an egg mass on the bark of an apple tree, collected in the field at East Bethany. The cluster is usually oval, rather flat, and green in color. When hatched the eggs are shining white. Sanderson and Jackson found the average number of eggs deposited by a single moth to be 117.

THE UGLY-NEST LEAF-ROLLER

(*Archips cerasivorana*)

This is another species of leaf-roller that was rather abundant last season. It works on the cultivated cherry and on the wild chokecherry. The nests are very conspicuous because they are large and sometimes numerous. The nests are made by the larvæ fastening together all the leaves and twigs on one branch. When the pupæ change to moths they work out of the tangled mass and their empty skins may be seen projecting from all sides of the nest. Last season the moths appeared in great numbers in our cages during the latter part of June.

The eggs.— So far as the writer is aware, the egg masses have never been figured. The eggs were found in 1900 by C. M. Weed on the stems of the chokecherry near the ground.

Some moths that appeared in our cages in June were fed on sugar, and on July 1 egg masses were found fastened to the sides of the cages. Some pieces of branches of cherry were then placed in the cages and many eggs were deposited on the bark (Fig. 76). These eggs, deposited July 2, are still (January, 1912) in our cold house unhatched, and will of course remain so until next spring, there being only one brood a season.

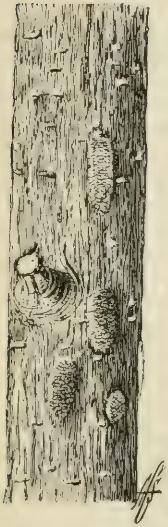
FIG. 76.—*Eggs of the ugly-nest leaf-roller*

The egg masses are usually flat, long, and narrow, and are rather reddish yellow in color at first, being somewhat conspicuous on the bark. Later they turn brown and become hard to distinguish. Occasionally a small mass, more or less circular in outline, will be deposited. Half a dozen average masses measured from three tenths to three fifths of an inch in length and about one tenth of an inch in width (Fig. 77).

The moth.— The moth has bright ocher-yellow wings that expand from four fifths of an inch to over an inch (Fig. 73).

Parasites.— Three dipterous parasites, kindly determined by W. R. Thompson, were bred from *A. cerasivorana*, namely, *Phorocera tortricis*, *Dichætoneura leucoptera*, and *Carcelia pyste*. In addition, a small braconid, *Triclistus pygmæus* Cress. var., and an ichneumon, *Macrocentrus cerasivoranæ* Vier., were reared.

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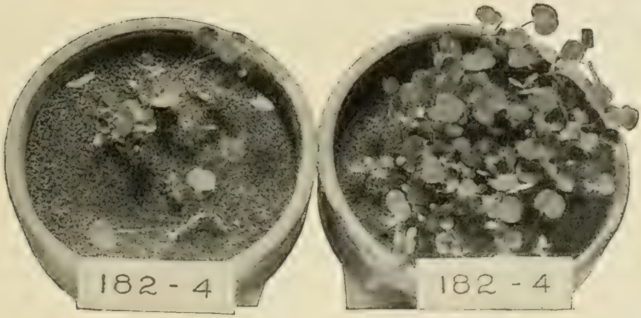
THE COLLEGE OF AGRICULTURE

Department of Plant-Breeding

GERMINATION OF SEED AS AFFECTED BY SULFURIC ACID TREATMENT



Untreated *Treated*

By HARRY H. LOVE and CLYDE E. LEIGHTY

ITHACA, N. Y.
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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

GERMINATION OF SEED AS AFFECTED BY SULFURIC ACID TREATMENT *

HARRY H. LOVE AND CLYDE E. LEIGHTY

The seed of many species of leguminous plants usually contains a considerable amount of seed that germinates slowly or not at all. Such seed is often referred to as " hard seed." Very frequently there is so much of this hard seed present that germination tests, even when continued for three weeks, give results entirely misleading as to the viability of the sample or lot of seed. When such seed is sown in the ordinary way, a very poor stand of plants is usually secured. This is especially true in dry seasons or in regions of light rainfall. In experimental work, where the growth of every seed is important, the presence of hard seed often brings the experiment to an untimely end. Some method, therefore, of obviating this difficulty should be of value both to farmers and to those engaged in experimental work.

It is the purpose of this paper to set forth a method of treatment for hard, leguminous seed that will practically do away with delayed germination. This method was first discovered by one of the writers in 1906. Some breeding work on red clover was being done, but it was found that much of the seed germinated poorly. Examination of the seed and further tests proved that the poor germination was due, without doubt, to the presence of hard seed in the lines being used. Experiments were instituted in which the seed coat was pricked with a needle or burned with a hot needle. It was found that when the seed coat was thus broken immediate germination usually ensued. The seed was also treated with many different chemical solutions in an effort to find one that would bring about the result desired. Among these was sulfuric acid of various strengths. As a result of these tests, the only chemical treatment that hastened and increased germination to any marked degree was immersion in concentrated sulfuric acid (sp. gr. 1.84) for a few minutes. The results obtained by this treatment were so uniformly good that, for the benefit of others who were experiencing the same difficulty with hard seed, it was decided to bring together some results for publication.

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The writers desire at this time to acknowledge the kindness of Dr. L. H. Smith and J. B. Park, of the Illinois Agricultural Experiment

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Station, and of E. Brown and H. N. Vinall, of the United States Department of Agriculture, who furnished some seed for certain of the tests. They also wish to acknowledge the kindness of E. T. Coker, of Society Hill, S. C., who made a field test of some treated cotton seed. The preliminary tests that led to the use of the method were made in the laboratory of Dr. C. F. Hottes, of the University of Illinois.

REVIEW OF LITERATURE

That others have experienced difficulty from hard seed and have devised means of overcoming it, is shown by the following extract from a letter by Professor C. G. Williams, of the Ohio Agricultural Experiment Station:

" Regarding our trouble in getting clover seed, which we are using for plant-breeding purposes, to germinate, we find a great degree of variation in this particular with different plants. With some few 80 to 90 per cent of the seed germinates promptly; with others only 5 to 10 per cent. While I do not have any accurate data for you on this subject, I feel reasonably safe in saying that fully three fourths of our plants show 20 per cent germination or below. We are getting very good results from rubbing the seed lightly between sheets of a very fine sandpaper. We line a small box with this sandpaper, then rub the seed gently. This is giving us very good germination. This treatment, of course, would be impossible on a large scale."

Many experiments have been conducted by different investigators in order to determine methods of treatment for hard seed, looking toward increased germination. In such experiments a large number of different chemicals and enzymes have been used with varied success. Immersing the seed in hot water or pricking it with a needle, as well as other mechanical treatments, have been used and often have shown increased germination. Certain German seed laboratories have used some of these different methods for scratching or breaking the seed coats in order to increase germination. Rostrup[1] was one of the first investigators to use sulfuric acid on hard seed. A sample of *Lathyrus sylvestrus* was placed in concentrated sulfuric acid for one minute, and then, with an untreated sample of the same, was placed to germinate. At the end of 320 days the untreated seed showed a germination of 76 per cent, while the treated seed gave a germination of 100 per cent. Rostrup treated a sample of flat pea seed with acid and obtained a germination, at the end of 60 days, of 28 per cent for the untreated seed and 84 per cent for the treated. Red clover seed left in concentrated sulfuric acid for 24 hours still contained 9 per cent viable seed.

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[1] See " Literature," page 336, for reference.

Following the work of Rostrup came that of Todaro,[1] who, working independently, found that concentrated sulfuric acid of a density of 1.84 acted upon hard seeds of many leguminous plants, rendering them capable of prompt germination. Hard seeds of various leguminous species were found to withstand immersion in concentrated sulfuric acid without any injury to their viability, for about one hour at a temperature of 25 to 28° C., or a somewhat longer period at a lower temperature. In all the experiments with leguminous seeds treated with concentrated sulfuric acid, the germination of the hard seeds was effected and a more rapid and more uniform sprouting was secured. Upon such seed as sulla, bird's-foot clover, *Melilotus*, black medick, and others, it was shown that concentrated sulfuric acid not only secured the greater total germination but appreciably hastened it. Cuscuta seeds showed that they were not only resistant to the action of sulfuric acid, but their germination was in many cases favored by the treatment. The seeds of *Plantago lanceolata*, verbena, *Rumex*, spurry, foxtail, and some other seeds that frequently occur as impurities in red clover seed, were all destroyed by a brief immersion in the sulfuric acid, without any detriment whatever to the red clover seed.

Todaro concluded that were the seeds left to dry after treatment they would not show the effect of the immersion in acid. This conclusion, however, is at variance with the results obtained by the authors of this bulletin.

Later Thornber[2] used sulfuric acid and found that in connection with the germination experiments the seed of acacia, mesquite, honey locust, locust, and Kentucky coffee trees were made to germinate readily when immersed for a short time in concentrated sulfuric acid in which chromic acid had been dissolved, and then neutralized in a dilute solution of potassium hydrate.

Schneider-Orelli[3] conducted experiments with a number of species of *Medicago* and found that when the seed was cut or filed so that the seed coat was punctured, a good germination was effected. Sulfuric acid treatment also gave good germination. More than three fourths of the treated seed germinated, while only 3 out of 20 of the check lot sprouted.

Sulfuric acid was tried by Bolley[4] on several samples containing hard seed, and it was found that the germination was markedly increased.

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[1] See "Literature," page 336, for reference.

[2] Ibid.

[3] Ibid.

[4] Ibid.

Bolley found the following amounts of hard seed in samples of different agricultural seeds:

TABLE 1

Record number of sample and kind of seed	Number germinated after 10-day test	Number hard at end of 10 days
Alfalfa No. 464	22	45
Alfalfa No. 474	43	50
Alfalfa No. 1165	72	12
Alfalfa No. 1210	56	40
Alfalfa No. 1420	90	9
Alfalfa No. 1434	70	25
Alfalfa No. 1590	80	18
Alfalfa No. 1594	71	18
Red clover No. 1156	74	15
Red clover No. 1159	44	51
Red clover No. 1191	84	18
Red clover No. 1192	73	16
Alsike No. 1435	86	15

MATERIAL AND METHODS

The seeds used in the following experiments were obtained from many sources. Some, as stated above, were furnished by the Illinois Experiment Station and some by the Bureau of Plant Industry of the United States Department of Agriculture; other seeds were gathered in and about Ithaca; while still other lots were obtained from seedsmen and from laboratory stock.

The acid used was either C. P. sulfuric or commercial sulfuric of about 1.84 specific gravity. The concentrated acid was used for all the tests. The other apparatus used was such as is found in any ordinary laboratory.

When there is only a small amount of seed to be treated, such as the seed from a single head of clover or from a single clover plant, amounting to not more than a few hundred seeds, the following method may be employed:

Place the seed in a small homeopathic vial or test tube. Pour on the seed a quantity of concentrated sulfuric acid equal to about five or six times the volume of the seed. Stir the mixture thoroughly with a stirring rod until all seeds are completely covered with the acid. Allow to stand for the time desired at ordinary room temperature. (See tables and conclusions for the length of time.) At the end of this time allow water from a faucet to run into the vial or test tube until it is nearly full, then quickly pour the entire contents into a strainer (an ordinary tea strainer is used for this purpose) and wash quickly with water. (If this method is used the work should be done over a porcelain or other acid-resistant sink, and the waste acid washed away with water.) Wash for five minutes in running water or until the seed is entirely free from acid. The seed may be planted immediately or it may be allowed to dry before planting, the former process being preferable for small lots of seed.

RED CLOVER SEED

The preliminary work on the treatment of clover seed was conducted by treating it with acid for only 10 minutes. This treatment, as is shown later, did not give so good results as a longer treatment would have given.

The earlier work was on the treatment of some seed obtained from the Illinois Experiment Station. This seed was from some of the different strains which that station was breeding. Part of the seed from each sample had been sown in the field and some of it had given very poor germination. This seed was from individual heads from different plants, and shows the great variation relative to germination that exists in different plants. The results of the field trials with these lines are shown in Table 2.

TABLE 2. RED CLOVER SEED

Tests of germination in field, between blotters, and in sand pots, untreated and treated with concentrated sulfuric acid (sp. gr. 1.84) for 10 minutes

Lot no.	Per cent germination				
	In field	Between blotters		In sand pots	
	Untreated	Untreated	Treated	Untreated	Treated
101	23	16	76	28	68
127	90	48	72	63	69
157	27	14	80	12	68
162	20	10	84	4	70
172	27	8	26	13	23
182	13	16	88	20	70
184	10	12	92	3	94
189	20	22	50	32	67
192	17	26	46	29	47
197	30	22	74	18	85
Average per cent	27.7	19.4	68.8	22.2	66.1

This table shows that seed No. 127 gave a very good germination of 90 per cent in the field test, while No. 184 gave only 10 per cent. Thus we see that seed from some plants gives a very high percentage of germination, while that from others has a very small amount of seed that germinates readily. The seed from the different plants was handled alike in curing and in planting.

One of the questions arising in this work is whether similar results from treated seed would obtain when the test is made in the soil rather than between blotting papers. So when this work was undertaken, one lot of seed from each of several samples was treated with acid for 10 minutes and placed between moist blotting papers, while another lot was treated with acid in the same manner and then planted in sand in pots. At the same time checks for each lot were run. This check seed was soaked in water, then placed between moist blotting paper; or, for the soil test, it was planted in sand. Since, as stated above, some of this seed had been planted in the field at the Illinois Experiment Station, the results obtained there will be given also. These results are shown in Table 2, under the heading "Per cent germination in field."

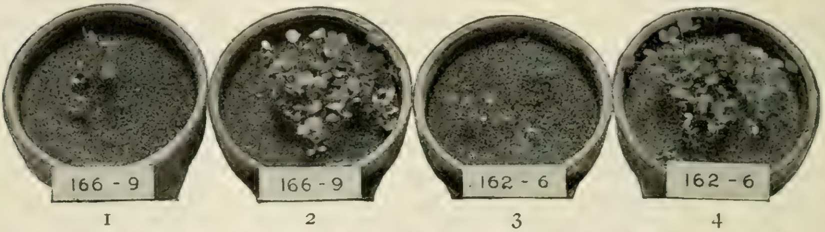

FIG. 78.—*Soil tests of treated and untreated clover seed. Seed in pots 1 and 3 untreated. Seed in pots 2 and 4 treated*

On examining this table one sees that most of the seed gave a very poor germination in the field and also in the checks, whether planted in sand or germinated between blotting paper. In several instances the check seed gave a lower germination than did the field test. This may be explained in part by the fact that the checks were run two years after the field test was made. In the case of seed Nos. 127 and 172, a lower germination was obtained for the treated seed than the field test gave. This is very likely due to the age of the seed. In all cases, with the exception of the two mentioned, the acid treatment gave a higher rate of germination than did the untreated seed in the field test. Several of the lots showed a great increase after acid treatment. Later work showed that a longer acid treatment than 10 minutes was better for most clover seed, so it is possible that had these samples been treated for a longer time a much higher rate of germination would have been obtained. The averages for the different kinds of treatment are 27.7 for the field test, 20.8 for the checks, and 67.45 for the treated seed. The seeds that were germinated between blotting papers gave a germination per cent of 68.8, while those planted in sand germinated at the rate of 66.1 per cent.

These results agree so closely that it is evident the treated seeds would germinate as well when planted in the soil as they show in the laboratory tests.

The lots of clover seed dealt with in Table 3 were from selected lines that were being propagated by an experiment station* in its breeding work. The seed of the different lots was grown in 1910 and was threshed from the plants after these were thoroughly and carefully cured. After threshing, the seed was kept for a time in the laboratory, in ordinary homeopathic vials, and later in paper envelopes. The action of sulfuric acid on all of these lots of seed experimented with is shown; it cannot be said, therefore, that only those lots showing beneficial results from acid treatment have been singled out and presented.

TABLE 3. RED CLOVER SEED

Effect of concentrated sulfuric acid (sp. gr. 1.83) on germination. (100 seeds used in each test)

Lot no.	Treatment Soaked in	Number of seeds germinated after			Average of duplicate tests
		5 days	9 days	21 days	
I–1–1	Water 120 min....................	19	22	23	
2	Water 120 min....................	34	35	36	29.5
3	Conc. sulfuric acid 30 min..........	98	98	98	
4	Conc. sulfuric acid 30 min..........	95	95	95	96.5
5	Conc. sulfuric acid 60 min..........	99	99	99	
6	Conc. sulfuric acid 60 min..........	97	97	97	98
I–2–1	Water 120 min....................	20	22	23	
2	Water 120 min....................	17	19	19	21
3	Conc. sulfuric acid 30 min..........	91	92	93	
4	Conc. sulfuric acid 30 min..........	94	94	95	94
5	Conc. sulfuric acid 60 min..........	98	98	98	
6	Conc. sulfuric acid 60 min..........	98	98	98	98
I–3–1	Conc. sulfuric acid 15 min.(*a*).......	64	66	67	
2	Conc. sulfuric acid 15 min..........	57	64	65	66
3	Conc. sulfuric acid 30 min..........	77	85	85	
4	Conc. sulfuric acid 30 min..........	78	78	78	81.5
5	Conc. sulfuric acid 60 min..........	74	77	77	
6	Conc. sulfuric acid 60 min..........	73	77	77	77
I–4–1	Water 120 min....................	22	28	28	
2	Water 120 min....................	21	28	28	28
3	Conc. sulfuric acid 30 min..........	76	76	76	
4	Conc. sulfuric acid 30 min..........	89	89	90	83
5	Conc. sulfuric acid 60 min..........	96	96	96	
6	Conc. sulfuric acid 60 min..........	97	97	97	96.5

(*a*) Unfortunately no check without acid treatment was run on this lot.

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* This seed was obtained from the University of Illinois.

TABLE 3. RED CLOVER SEED — (*Continued.*)

Lot no.	Treatment Soaked in	Number of seeds germinated after 5 days	9 days	21 days	Average of duplicate tests
I–5–1	Water 120 min....................	27	29	29	
2	Water 120 min....................	28	28	28	28.5
3	Conc. sulfuric acid 30 min..........	90	91	92	
4	Conc. sulfuric acid 30 min..........	92	93	95	93.5
5	Conc. sulfuric acid 60 min..........	91	91	91	
6	Conc. sulfuric acid 60 min..........	91	91	91	91
I–6–1	Water 120 min....................	38	39	39	
2	Water 120 min....................	25	25	25	32
3	Conc. sulfuric acid 30 min..........	81	82	82	
4	Conc. sulfuric acid 30 min..........	95	96	97	89.5
5	Conc. sulfuric acid 60 min..........	90	91	91	
6	Conc. sulfuric acid 60 min..........	91	92	92	91.5
I–14–1	Water 120 min....................	49	77	82	
2	Water 120 min....................	47	77	79	80.5
5	Conc. sulfuric acid 60 min..........	86	88	88	
6	Conc. sulfuric acid 60 min..........	84	86	87	87.5

Two checks were run on each lot, excepting Lot I–3. In order to compensate for the washing with water which acid-treated seeds received to remove all free acid, these check lots were soaked in water at a temperature of about 20° C. for two hours before being placed in the germinator. Other lots of the same seed were soaked in concentrated sulfuric acid (sp. gr. 1.83) for 15, 30, or 60 minutes as indicated in the table above, and thoroughly washed in running water so as to remove all traces of acid. All the lots of seed, both checks and acid-treated, were germinated under similar conditions at the same time, between moist blotters in the germinator.

It is seen in Table 3 that sulfuric acid treatment has been of benefit in causing germination in every case in these lots of clover seed. The differences in germination between the checks and the treated seed are remarkably large in nearly every case. In Lot I–2, where the greatest benefit is observed, the checks after 21 days showed an average germination of 21 per cent, while the samples treated with concentrated sulfuric acid for 30 minutes showed an average germination of 94 per cent and those samples treated with concentrated sulfuric acid for 60 minutes showed an average germination of 98 per cent. Other lots tested show about the same differences between the untreated and the treated seed. The least difference is observed in Lot I–14. The checks here showed an average germination of 80.5 per cent after 21 days, while the samples treated with concentrated sulfuric acid for 60 minutes showed an average germination of 87.5 per cent. But even in this case the germination was much more uniform in the treated seed, for an average of 85 per cent had germinated in these samples at the end of the first five days, while the

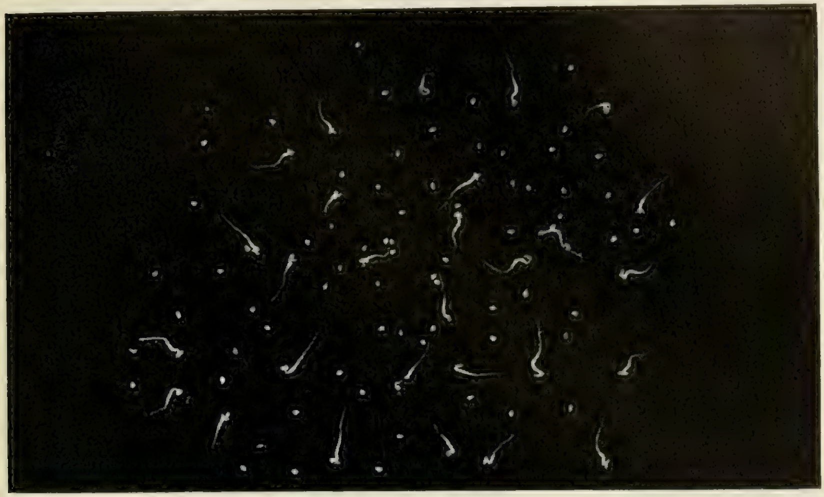

FIG. 79.—*Red clover seed I-5-2. One hundred seeds of red clover not treated with sulfuric acid; twenty-eight per cent germinated after 5 days in germinator*

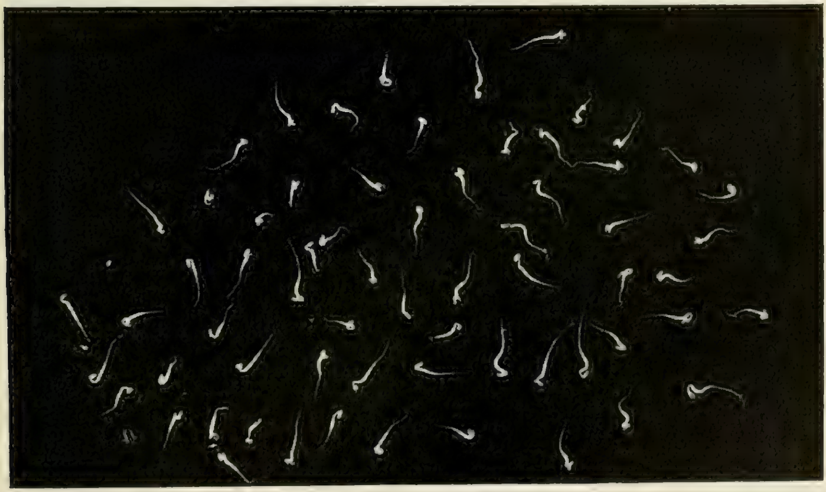

FIG. 80.—*Red clover seed I-5-2. Sixty-seven seeds of red clover, shown in Fig. 79, which had not germinated after 21 days. These were then treated with concentrated sulfuric acid for 30 minutes and placed in the germinator for 4 days. Sixty-five seeds were then germinated*

untreated seed after the same time showed an average of only 48 per cent. In all other lots, both treated and untreated, the total percentages germinated after 21 days are not much larger than after the first five days.

As is seen in Table 3, many of the seeds that did not receive acid treatment failed to germinate after 21 days between moist blotters. On examination, a few of these non-germinated seeds were found to be dead, being soft and somewhat decayed. Most of the non-germinated seeds, however, were bright in color, and the seed coats were hard and firm. Practically all of these bright-colored seeds were really alive, as was shown by the subsequent tests given them. In order to further test these hard, bright-colored seeds, they were taken from between the moist blotters and treated at once with concentrated sulfuric acid for 30 or 60 minutes, after which they were thoroughly washed and again placed in the germinator between moist blotters.

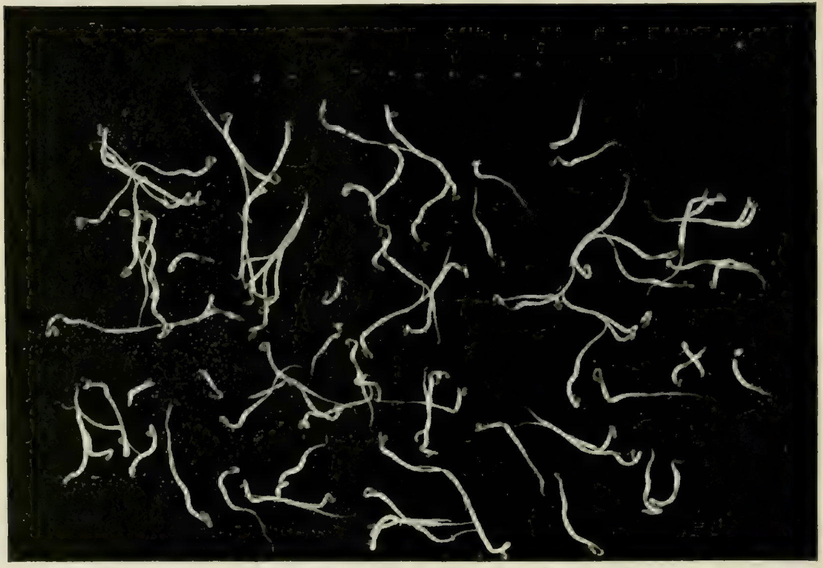

FIG. 81—*Red clover seed I-5-5. One hundred seeds of red clover treated with concentrated sulfuric acid for 60 minutes. Ninety-one per cent germinated after 5 days. Nine " hard seeds " remain*

The number of seeds from each lot thus treated is shown in Table 4, in the column " Number of seeds." Thus, from the lot in Table 3 marked I-1-1, 72 seeds were taken for the further treatment shown in Table 4. These 72 seeds, as indicated in Table 4, had received the " previous treatment " of being soaked in water 2 hours and remaining between moist blotters in the germinator for 21 days. After treatment with concen-

TABLE 4. RED CLOVER SEED

Further tests on seeds not germinated after 21 days in germinator, as shown in Table 3

Lot no.	Number of seeds	Previous treatment (Table 3) Soaked in	Treatment Soaked in concentrated sulfuric acid	Number of seeds germinated after			Total per cent after 14 days
				4 days	7 days	14 days	
I-1- 1	72	Water 2 hrs. In germinator 21 days	1 hour	68	71	71	98.6
I-1- 2	64	Water 2 hrs. In germinator 21 days	1 hour	57	60	60	93.8
I-2- 1	77	Water 2 hrs. In germinator 21 days	1 hour	73	73	73	94.8
I-2- 2	81	Water 2 hrs. In germinator 21 days	1 hour	73	73	74	91.4
I-3- 1	13	Conc. sulfuric acid 15 min. In germinator 21 days	1 hour	13	13	13	100
I-3- 1	20(D)	Conc. sulfuric acid 15 min. In germinator 21 days	1 hour	0	0	0	0
I-3- 2	6	Conc. sulfuric acid 15 min. In germinator 21 days	1 hour	6	6	6	100
I-4 1	69	Water 2 hrs. In germinator 21 days	30 min	44	48	48	69.6
I-4- 2	67	Water 2 hrs. In germinator 21 days	30 min	(a)	63	64	95.5
I-4- {3, 4}	8	Conc. sulfuric acid 30 min. In germinator 21 days	30 min	7	7	7	87.5
I-5- 1	70	Water 2 hrs. In germinator 21 days	30 min	70	70	70	100
I-5- 2	67	Water 2 hrs. In germinator 21 days	30 min	65	65	65	97
I-5- {3, 4, 5}	12	Conc. sulfuric acid 30 min. for 10 seeds; 60 min. for 2 seeds. In germinator 21 days	30 min	12	12	12	100
I-6- 1	58	Water 2 hrs. In germinator 21 days	30 min	(a)	16	19	32.8
I-6- 2	67	Water 2 hrs. In germinator 21 days	30 min	61	61	61	91

(D) Apparently dead when treated second time.
(a) No count taken.

trated sulfuric acid for 60 minutes these seeds were again placed in the germinator, with the result that 68 of them had germinated at the end of 4 days, and 71, or 98.6 per cent, at the end of 7 days.

From 87 to 100 per cent of the seeds in most lots, treated as shown in Table 4, had germinated after 4 days. All ungerminated seeds, however, were left longer in the germinator and counts were again made at the end of 7 and 14 days, with the results shown.

From an inspection of this table it is seen that Lots I–3–1 and I–3–2 had been previously treated with concentrated sulfuric acid for 15 minutes; and that Lots I–5–(3, 4, and 5) had received such treatment for 30 or 60 minutes. These seeds after being again treated with acid (with the exception of those marked " D," which were soft, decayed, and doubtless dead when put into acid) gave 100 per cent germination.

This would seem to show quite conclusively that treatment of clover seed with concentrated sulfuric acid will often hasten germination, or will even make germination possible when otherwise it would be much delayed or would never occur.

After these lots of clover seed had been in the germinator 14 days, as shown in Table 4, final counts were taken. It was seen that there still remained a few ungerminated seeds, which were bright, hard, and apparently alive. In order to test these few seeds further, a number of them were treated again with concentrated sulfuric acid for 30 minutes, after which they were thoroughly washed in water and again placed in the germinator. The results are shown in Table 5.

It is seen that every seed except 5 had germinated at the end of 3 days. The five not germinated were apparently alive, but were not tested longer.

These tests, besides showing that sulfuric acid treatment of clover seed is often beneficial to hasten and produce germination, show that some seeds require acid treatment for a considerable length of time: 15 or 30 minutes is sometimes not long enough. They also show the great resistance that some clover seeds have to the action of water on their seed coats. Some of the seeds experimented with were between moist blotters for 21 days without germinating; then they withstood the action of concentrated sulfuric acid for 30 to 60 minutes and were 14 days between moist blotters without germinating. On further treatment with concentrated sulfuric acid for 30 minutes (as shown in Table 5), practically all of these most resistant seeds germinated.

Effect of treatment for different lengths of time

In order to determine the length of time during which clover seed could be left in concentrated sulfuric acid (sp. gr. 1.83) without injury, several experiments were tried, the results of which are given in Tables 6 and 7.

TABLE 5. RED CLOVER SEED

Further tests on seeds not germinated after 35 days in germinator and treatments as shown in Tables 3 and 4

Lot no.	Number of seeds	Previous treatment (Tables 3 and 4) Soaked in	Treatment Soaked in	Number of seeds germinated after 3 days
I-2-1	4	Water 2 hours, in germinator 21 days; concentrated sulfuric acid 1 hour, in germinator 14 days	Concentrated sulfuric acid 30 minutes, then placed in germinator between moist blotters.	
I-2-2	6			
I-4-1	20	Ditto, except in concentrated sulfuric acid 30 minutes		
I-4-2	3			
I-4-3 and 4	1	Concentrated sulfuric acid 30 minutes, in germinator 21 days; concentrated sulfuric acid 30 minutes, in germinator 14 days		
I-6-2	6	....		
Total	40	....	....	35
I-6-1	38	I-6-1 and I-6-2 same as I-4-1 and I-4-2	Ditto	38

TABLE 6. RED CLOVER SEED

Treatment of seed with concentrated sulfuric acid (sp. gr. 1.83) for different lengths of time in order to determine the power of resistance. 100 seeds used in each test

Lot no.	Treatment Soaked in	Number of seeds germinated after						Average of duplicate tests
		4 days	6 days	9 days	11 days	17 days	27 days	
11 y....	Water 30 min. Checks	83	86	86	86	88	88	
11 z....	Water 60 min.	77	80	80	80	80	81	
11 x....	Water 80 min.	82	86	86	86	86	86	
11 z'...	Water 150 min.	75	80	80	80	80	80	83.8
11 m...	Conc. sulfuric acid 10 min.	88	93	93	93	93	94	
11 a....	Conc. sulfuric acid 10 min.	84	84	85	85	85	86	90
11 b....	Conc. sulfuric acid 20 min.	80	82	83	83	85	85	
11 c....	Conc. sulfuric acid 20 min.	86	87	87	88	88	90	87.5
11 d....	Conc. sulfuric acid 30 min.	91	92	92	92	92	92	
11 e....	Conc. sulfuric acid 30 min.	88	93	93	93	93	93	92.5
11 f....	Conc. sulfuric acid 40 min.	88	88	89	89	89	89	
11 g....	Conc. sulfuric acid 40 min.	84	87	88	89	89	89	89
11 j....	Conc. sulfuric acid 60 min.	94	95	96	96	96	96	
11 k....	Conc. sulfuric acid 60 min.	88	90	90	90	90	90	93
11 n....	Conc. sulfuric acid 100 min.	94	97	97	98	98	98	
11 o....	Conc. sulfuric acid 100 min.	91	91	91	91	91	91	94.5
11 p....	Conc. sulfuric acid 120 min.	83	85	85	85	85	85	
11 q....	Conc. sulfuric acid 120 min.	78	87	88	88	88	88	86.5
11 r....	Conc. sulfuric acid 230 min. (*a*)	57	66	68	68	68	68	
11 s....	Conc. sulfuric acid 230 min. (*a*)	67	75	77	77	77	77	72.5
11 t....	Conc. sulfuric acid 240 min. (*a*)	51	58	58	58	58	58	58

(*a*) Many of the seeds treated for this length of time had their seed coats injured by the acid and did not give a normal germination, the radicle being injured in many cases.

TABLE 7. RED CLOVER SEED

Treatment of seed with concentrated sulfuric acid (sp. gr. 1.83) for different lengths of time in order to determine the power of resistance. 100 seeds used in each test

Lot no.	Treatment Soaked in	Number of seeds germinated after							Average of duplicate tests
		3 days	6 days	8 days	11 days	13 days	19 days	29 days	
12 x′	Water 10 min. Checks	(a)27	87	89	89	89	89	90	
12 x	Water 40 min.	70	91	91	91	91	91	91	
12 y	Water 60 min.	71	88	89	89	89	89	89	
12 z	Water 230 min.	84	89	90	91	91	91	92	90.5
12 a	Conc. sulfuric acid 10 min	91	94	94	94	94	94	94	
12 b	Conc. sulfuric acid 10 min	95	98	98	98	98	98	98	96
		2 days	5 days	7 days	10 days	12 days	18 days	28 days	
12 c	Conc. sulfuric acid 20 min	77	91	92	93	93	93	93	
12 d	Conc. sulfuric acid 20 min	86	91	93	94	95	95	96	94.5
12 e	Conc. sulfuric acid 30 min	85	94	97	97	97	97	97	
12 f	Conc. sulfuric acid 30 min	78	92	92	92	92	93	93	95
12 g	Conc. sulfuric acid 40 min	76	92	92	92	93	93	93	
12 h	Conc. sulfuric acid 40 min	79	96	97	97	97	97	97	95
12 i	Conc. sulfuric acid 50 min	73	95	95	95	95	96	96	
12 j	Conc. sulfuric acid 50 min	73	86	88	88	90	90	90	93
		4 days	6 days	9 days	11 days		17 days	27 days	
12 k	Conc. sulfuric acid 60 min	93	95	95	95	......	95	95	
12 l	Conc. sulfuric acid 60 min	90	91	91	91	......	91	91	93
12 m	Conc. sulfuric acid 80 min	92	92	92	93	......	93	93	
12 n	Conc. sulfuric acid 80 min	93	96	96	97	......	97	97	95
12 o	Conc. sulfuric acid 100 min	79	87	87	87	......	87	87	
12 p	Conc. sulfuric acid 100 min	90	92	92	92	......	92	92	89.5
12 q	Conc. sulfuric acid 120 min	85	91	94	94	......	94	94	
12 r	Conc. sulfuric acid 120 min	88	93	94	94	......	94	94	94

(a) After 2 days.

Two lots of seed were purchased on the open market from seed dealers. These lots were grown in 1910 and the tests on them were made in December, 1910. The lot marked "11" retailed at $11 a bushel, and the lot marked "12" at $12 a bushel. Samples of 100 seeds each were counted out from these two lots, which samples were soaked in water or in acid for varying lengths of time, as shown in Tables 6 and 7. (In no case does temperature enter as a factor in the treatment accorded seed. All were treated with water and with acid at about the same temperature, which was near 70° F. Acid-treated seeds and their checks were handled at the same time and placed in the germinator together, except as noted.)

It is seen in Tables 6 and 7 that the seed experimented with is not noticeably injured by treatment with concentrated sulfuric acid (sp. gr. 1.83) for lengths of time up to 120 minutes. When the seed is left in longer, however, injury results to the seed coats and to the radicles of many seeds. This is especially true for seed left in the acid for 230 to 240 minutes. The maximum germination was secured in Lot 12 after acid treatment for 10 minutes, but the maximum was only 1 per cent higher than for 30, 40, or 80 minutes treatment, and 2 per cent higher than for the 120 minutes treatment. The maximum germination in Lot 11 was secured from the samples treated with acid 100 minutes, but this percentage is but little larger than for lots treated with acid for a shorter time.

It is seen that these tests were made with lots of seed that germinated well when no acid treatment was given. The acid-treated seed, however, germinated, on the average, better than the untreated seed, as is shown in Table 8; in Lot 11 the difference in favor of the treated being 6.6 per cent, and in Lot 12, 3.4 per cent:

TABLE 8. RED CLOVER SEED
(Summary of Tables 6 and 7)

Lot no.	Percentage of untreated seeds (checks) germinated during test (27–29 days)	Percentage of seeds treated with concentrated sulfuric acid for 10 to 120 minutes, germinating during test (27–29 days)	Difference
11.........	83.8	90.4	6.6
12.........	90.5	93.9	3.4

The lots of seed Nos. 11 and 12 had been handled in a commercial way, which is necessarily somewhat different from the method used for seed that is kept in the laboratory for experimental purposes.

Effect of laboratory storage

Samples of these lots were stored in envelopes in a drawer of a laboratory desk for four months, or from December, 1910, to April, 1911. These samples were then treated as shown in Table 9, and a germination test was made:

TABLE 9. RED CLOVER SEED

Effect of concentrated sulfuric acid (sp. gr. 1.84) on germination. 100 seeds used in each test

Lot no.	Treatment Soaked in	Number of seeds germinated after				Average of duplicate tests	Average of previous duplicate tests
		4 days	6 days	9 days	23 days		
11 A...	Water, 20–22° C., 2 hrs	86	87	87	87		
B...	Water, 20–22° C., 2 hrs	87	87	87	87	87	83.8 (See Table 6) (10 min. treatment)
C...	Conc. sulfuric acid 15 min	95	95	95	95		
D...	Conc. sulfuric acid 15 min	87	87	87	87	91	90
E...	Conc. sulfuric acid 60 min	92	92	92	92		
F...	Conc. sulfuric acid 60 min	91	91	91	91	91.5	93
G...	Conc. sulfuric acid 120 min. (*a*)	49	57	(*b*)	......		
H...	Conc. sulfuric acid 120 min. (*a*)	51	63	(*b*)	......	60	86.5
K...	Conc. sulfuric acid 240 min. (*a*)	4	15	(*b*)	......	......	58
12 A...	Water, 20–22° C., 2 hrs	95	95	95	95		
B...	Water, 20–22° C., 2 hrs	88	88	88	88	91.5	90.5 (See Table 7) (10 min. treatment)
C...	Conc. sulfuric acid 15 min	95	95	95	95		
D...	Conc. sulfuric acid 15 min	94	94	94	94	94.5	96
E...	Conc. sulfuric acid 60 min	88	88	88	88		
F...	Conc. sulfuric acid 60 min	93	93	93	93	90.5	93
G...	Conc. sulfuric acid 120 min. (*a*)	25	40	(*b*)	......		
H...	Conc. sulfuric acid 120 min. (*a*)	47	69	(*b*)	......	54.5	94
K...	Conc. sulfuric acid 210 min. (*a*)	21	25	(*b*)	......	......	

(*a*) Seed coat badly injured by the acid. Radicles, when appearing, often damaged.
(*b*) Not counted on account of injured condition.

The results obtained, as shown in this table, are practically the same as those that were obtained in the first test, except, possibly, that the seeds treated for the longer times were more injured in the second test. The germination of the checks was about the same in each case, which would indicate that " hard seeds " are not due altogether to conditions of storage, but are probably due to inherent differences. Professor Williams recognizes this in his letter quoted above, in which he states that 80 to 90 per cent of the seed of some plants germinates promptly, while others give only 5 to 10 per cent.

Treatment of old seed

The question arises, will the sulfuric acid treatment induce better germination in old seeds of red clover? In order to test this, some lots of old seed were procured and samples from these were treated with concentrated sulfuric acid for different lengths of time, after which their germination was compared with untreated check samples from the same lots. All the seed, owing to age, conditions of storage, or otherwise, had lost largely in viability. The average germination of twenty samples from these lots, receiving no treatment, was 4.05 per cent; for twenty samples receiving sulfuric acid treatment for 10 minutes the average germination was 4.45 per cent.

Effect of drying after treatment

When small lots of seed are being dealt with, as is often the case in experimental work in which the yield of individual plants or of different lines is kept separate, it is possible to plant, immediately after washing, the seed that has been treated with acid. With larger lots, when the seed is to be sown broadcast or in a seeder, the moist seed must be dried before sowing. The question then arises, will the beneficial effects of acid treatment of hard seed still be manifest after drying has taken place? In order to determine this point, parts of several lots of seed were treated with concentrated sulfuric acid for one hour. After thorough washing the seeds were dried near a radiator for several days, as shown in Table 10, and then germinated between blotters without further treatment.

The results obtained from these tests are shown in Table 10. Lot I–2 showed a germination of 98.5 per cent after 5 days drying, as compared with 96 per cent secured without drying and with 21 per cent in the check. In a similar manner, all the other lots reported on in this table, after drying four to six days (i. e., becoming thoroughly dry), germinated practically as well as, or better than, the same lots did when drying out did not intervene between acid treatment and the germination test. The same is true for samples I–4–A and I–5–(A and B), in which cases 34 days intervened between the treatment and the test. In every case

TABLE 10. RED CLOVER SEED

Effect of concentrated sulfuric acid (sp. gr. 1.84) and thorough drying out, on germination. 100 seeds used in each case

Lot no.	Treatment Soaked in	Dried days(a)	Number of seeds germinated after			Average of duplicate tests	Average of tests, acid-treated not dried (Table 3)
			5 days	9 days	21 days		
I- 2- 1	Check Table 3	......	20	22	23		
2	Check Table 3	......	17	19	19	21	
a	Conc. sulfuric acid 1 hr	5	97	97	97		
b	Conc. sulfuric acid 1 hr	5	98	99	100	98.5	96
I- 4- 1	Check Table 3	......	22	28	28		
2	Check Table 3	......	21	28	28	28	
a	Conc. sulfuric acid 1 hr	5	97	98	98		
b	Conc. sulfuric acid 1 hr	5	96	96	96		
13	Conc. sulfuric acid 1 hr	4	94	94	94		
14	Conc. sulfuric acid 1 hr	4	95	95	95	95.8	89.8
I- 5- 1	Check Table 3	......	27	29	29		
2	Check Table 3	......	28	28	28	28.5	
a	Conc. sulfuric acid 1 hr	5	92	92	92		
b	Conc. sulfuric acid 1 hr	5	96	96	96	94	92.3
I- 6- 1	Check Table 3	......	38	39	39		
2	Check Table 3	......	25	25	25	32	
a	Conc. sulfuric acid 1 hr	5	89	89	90	90	90.5
I-14- 1	Check Table 3	......	49	77	82		
2	Check Table 3	......	47	77	79	80.5	
3	Conc. sulfuric acid 1 hr	6	89	91	91		
4	Conc. sulfuric acid 1 hr	6	92	92	92	91.5	87.5
I- 4- A	Conc. sulfuric acid 1 hr	34	97	97	97	97	89.8
I- 5- A	Conc. sulfuric acid 1 hr	34	92	92	92		
B	Conc. sulfuric acid 1 hr	34	94	94	94	93	92.3

(a) Thoroughly dried in every case.

there was a striking increase in germination over the check, due to the treatment. It can therefore be said that, without doubt, the beneficial effects of acid treatment of hard seed will still be manifest after drying has taken place. Seed, then, which has been treated in quantity for sowing, can be dried out after such treatment without decrease in its germinative ability.

Effect of washing after treatment

The question of method of treating seed with acid, or rather of removing the acid after treatment, may now be taken up. Table 11 is introduced here to show the injurious effects on germination of washing with water for too long a period after acid treatment. Samples of some of the lots reported on in previous tables were treated with concentrated sulfuric acid for periods of 1 or 2 hours, and these were then washed in water for 2 hours and subsequently dried for 5 or 6 days. The germinations then obtained are, on the average, quite poor, although there are individual exceptions. The seed coat, being softened by the acid, seems to be easily injured by the process of washing. It is evident from these tests that washing should not be continued, after acid treatment, for a longer time than is necessary to remove all acid from the seed, especially after the acid treatment has been long continued.

It may also be stated here that in the opinion of the writers it is seldom necessary to continue the acid treatment of any kind of clover seed for more than 30 minutes, and 15 minutes is often long enough. It seems that different kinds of seed and different lots of the same kind vary somewhat in their resistance to the action of acid, and for some lots a longer time of treatment is necessary than for other lots. This is a question that should be determined for different lots by individual tests. Usually, however, 15 to 30 minutes treatment is sufficient, the higher limit for those lots that have many hard seeds and the lower limit for those with few. When the germination is good in the natural condition, the acid treatment is of course unnecessary.

WHITE, ALSIKE, AND JAPAN CLOVER SEED

The action of concentrated sulfuric acid (sp. gr. 1.84) on the germination of the seed of several species of clover has been determined. The results obtained with the seed of white, alsike, and Japan clovers are given in Table 12. For the white and alsike clovers used, a treatment of 15 minutes gave the best results. For the Japan clover, which was unclipped, a treatment of 60 minutes was better. The seed coats of the white and alsike seeds were injured by 60-minute treatment and those of the Japan seed by treatment for more than 60 minutes. The germination of the white clover seed was increased from 76 per cent in the check

TABLE 11. RED CLOVER SEED

Effect of concentrated sulfuric acid (sp. gr. 1.83) and subsequent washing for two hours and then drying out, on germination. 100 seeds used in each case

Lot no.	Treatment Soaked in	Dried days	Number of seeds germinated after			Average of duplicates	Average of tests, acid treatment same lots not dried (Table 3)
			5 days	9 days	16 days		
I– 1– 7	Conc. sulfuric acid 1 hr., water 2 hrs.	6	0	15	15	16.5	97.3
8	Conc. sulfuric acid 1 hr., water 2 hrs.	6	8	18	18		
I– 2– 9	Conc. sulfuric acid 1 hr., water 2 hrs.	6	72	85	85	88	96
10	Conc. sulfuric acid 1 hr., water 2 hrs.	6	89	91	91		
I– 5– 9	Conc. sulfuric acid 2 hrs., water 2 hrs.	5	3	3	3	48.5	92.3
10	Conc. sulfuric acid 2 hrs., water 2 hrs.	5	94	94	94		
I– 6– 9	Conc. sulfuric acid 1 hr., water 2 hrs.	5	0	1	1	.5	90.5
10	Conc. sulfuric acid 1 hr., water 2 hrs.	5	0	0	0		

TABLE 12. WHITE, ALSIKE, AND JAPAN CLOVER

Effect of concentrated sulfuric acid (sp. gr. 1.84) on germination. 100 seeds used in each case. White and alsike seed two years old at time of test

Lot no.	Treatment Soaked in	Number of seeds germinated after				Average of duplicate tests
White		4 days	7 days	18 days		
1	None	61	67	67	......	
2	None	78	85	85	......	76
3	Conc. sulfuric acid 15 min	84	84	84	......	
4	Conc. sulfuric acid 15 min	77	87	88	......	86
5	Conc. sulfuric acid 60 min. (*a*)	66	76	76	......	
6	Conc. sulfuric acid 60 min. (*a*)	76	80	80	......	78
7	Conc. sulfuric acid 90 min. (*a*)	77	80	80	......	
8	Conc. sulfuric acid 90 min. (*a*)	71	75	80	......	80
Alsike						
1	None	74	80	83	......	
2	None	77	87	89	......	86
3	Conc. sulfuric acid 15 min	87	88	88	......	
4	Conc. sulfuric acid 15 min	98	98	98	......	93
5	Conc. sulfuric acid 60 min. (*a*)	90	91	92	......	
6	Conc. sulfuric acid 60 min. (*a*)	56	72	75	......	83.5
Japan		4 days	6 days	12 days	17 days	
a	None	0	2	63	71(*b*)	
b	None	0	0	68	78(*c*)	74.5
c	Conc. sulfuric acid 15 min	18	56	76	77	
d	Conc. sulfuric acid 15 min	20	53	71	71	74
e	Conc. sulfuric acid 60 min	75	85	88	89	
f	Conc. sulfuric acid 60 min	74	85	88	89	89
g	Conc. sulfuric acid 120 min. (*a*)	68	80	81	81	
h	Conc. sulfuric acid 120 min. (*a*)	50	60	60	66	73.5

(*a*) Seed coats injured by the treatment. (*b*) Twenty-nine apparently still alive. (*c*) Twenty-two apparently still alive.

to 86 per cent for the 15-minute acid treatment, where the maximum was obtained. The alsike clover seed was likewise increased from 86 per cent to 93 per cent. The germination of the Japan clover seed was increased from 74.5 per cent in the check to 89 per cent by the 60-minute acid treatment, where the maximum germination was attained.

ALFALFA SEED

The action of concentrated sulfuric acid (sp. gr. 1.84) on the germination of alfalfa seed has been determined on three different lots. The results obtained are given in Table 13. The germination of the check of Lot 29988 was 52.5 per cent. By a 15-minute acid treatment the maximum was obtained, the germination being raised to 90 per cent. Treatments for 60 minutes or longer injured the seed coats of the seed in this lot. The germination of the check of Lot 29986 was 56.5 per cent, which was raised to 99 per cent and 98.5 per cent by 15- and 60-minute treatments, respectively. The seed coats did not here appear to be injured by the 60-minute treatment, although injury was done by the 120-minute treatment. It appears that these two lots of seed have different powers of resistance to the action of acid. A reason for this may be found in the column headed " Seeds remaining apparently alive," where the numbers of seeds coming through a 17-day test in the germinator without germinating or decaying are given. It is seen that an average of 31 per cent remained in Lot 29988 and 37 per cent in Lot 29986. These lots of seed were tested by the Seed Laboratory of the United States Department of Agriculture, with the results that Lot 29988 gave a germination of 50.5 per cent, with 41 per cent hard seed; and Lot 29986 gave a germination of 43 per cent, with 53.5 per cent hard seed. These results coincide with the greater resistance shown by Lot 29986 to the action of acid.

The third lot of alfalfa seed reported on in this table was at least three years old and was of poor quality, containing much shriveled and inferior seed. The check here gave an average germination of 24.5 per cent, while the results for the 60-minute treatment were 30 per cent. The seed coats were injured by longer treatment.

SWEET CLOVER

In some parts of the United States sweet clover (*Melilotus alba*) is or promises to become an important crop, furnishing pasture and hay for stock-feeding and also being grown to enrich the soil. The seed is often difficult to germinate, however, and a large part usually fails to grow at all in dry seasons or in regions of light rainfall. This prevents as wide a use of the crop as it might otherwise have. A method, therefore, of

TABLE 13. ALFALFA SEED

Effect of concentrated sulfuric acid (sp. gr. 1.84) on germination. 100 seeds used in each test

Lot no.	Treatment Soaked in	Number of seeds germinated after				Seeds remaining apparently alive	Average of duplicate tests
		4 days	6 days	12 days	17 days		
29988							
a	No treatment	48	52	52	53	33	
b	No treatment	40	47	49	52	29	52.5
c	Conc. sulfuric acid 15 min	92	93	95	95	....	
d	Conc. sulfuric acid 15 min	84	84	84	85	2	90
e	Conc. sulfuric acid 60 min. (*a*)	81	83	83	83	....	
f	Conc. sulfuric acid 60 min. (*a*)	77	77	77	77	....	80
g	Conc. sulfuric acid 120 min. (*b*)	(*d*)	......	42	......	....	
h	Conc. sulfuric acid 120 min. (*b*)	(*d*)	......	48	......	....	45
29986							
a	No treatment	38	49	51	55	39	
b	No treatment	40	50	56	58	35	56.5
c	Conc. sulfuric acid 15 min	98	98	99	99	....	
d	Conc. sulfuric acid 15 min	98	98	98	99	1	99
e	Conc. sulfuric acid 60 min	97	98	98	98	....	
f	Conc. sulfuric acid 60 min	99	99	99	99	....	98.5
g	Conc. sulfuric acid 120 min. (*b*)	(*d*)	......	50	......	....	
h	Conc. sulfuric acid 120 min. (*b*)	(*d*)	......	73	......	....	61.5
101 (*c*)	No treatment	23	23	23	24	....	
102 (*c*)	No treatment	23	23	23	25	....	24.5
103 (*c*)	Conc. sulfuric acid 60 min	32	32	32	32	....	
104 (*c*)	Conc. sulfuric acid 60 min	28	28	28	28	....	30
105 (*c*)	Conc. sulfuric acid 120 min. (*b*)	15	15	15	15	....	
106 (*c*)	Conc. sulfuric acid 120 min. (*b*)	17	17	17	17	....	16

(*a*) Seed coats slightly injured by treatment. (*b*) Seed coats badly injured by treatment. (*c*) Seed at least three years old at time of test; also poor in quality. (*d*) No counts were taken until the twelfth day and then tests were discontinued.

hastening and increasing germination of this seed should be of great importance to certain sections of the country.

The results obtained by treating sweet clover seed (*Melilotus alba*) with concentrated sulfuric acid (sp. gr. 1.84) are given in Table 14. This seed was grown in central Illinois in 1910 and was handled in small quantity in an experiment, having, therefore, the most favorable conditions for curing and for drying out thoroughly. The check tests gave an average germination of only 4.5 per cent. Treatment with concentrated sulfuric acid for 25, 60, and 120 minutes resulted in germinations of 98 per cent, 99 per cent, and 99 per cent, respectively. These percentages were raised to 100 per cent, 99 per cent, and 100 per cent, respectively, by treating the six seeds not germinating after 22 days, in tests 3, 4, and 8, with acid for 30 minutes more and again placing them in the germinator for 4 days. The seeds not germinated in the checks, Nos. 1 and 2, after 22 days were taken from between the moist blotters and treated immediately with concentrated sulfuric acid (sp. gr. 1.84) for 30 minutes. At the end of 4 days after these were again placed in the germinator, 182 of the 188 seeds treated were germinated, and at the end of 17 days 183 were germinated, while 5 yet remained ungerminated but apparently alive. No further tests were made with these.

The seed coats of this lot of seed were somewhat injured by the 120-minute treatment, being eaten through in places. Perfect germination took place, however, in these cases. In this connection, H. N. Vinall, of the Office of Forage Crop Investigations of the United States Department of Agriculture, writes concerning some other lots of seed: " You will notice that above 30 minutes the seed is pretty badly injured, and our germinations show that the 15-minute treatment gave the strongest germinations in most cases. I am running a duplicate set of seed in which the seed treated 30 minutes is giving the best results. The seed used had close to 50 per cent of hard seed in it. The results indicate that farmers will have to be cautioned very strongly against handling the sulfuric acid treatment loosely, as it appears the seed can be very readily injured by so doing."

In order to test the effect of drying out of the seed after treatment with sulfuric acid and washing with water, two samples treated with acid for one hour were allowed to dry out thoroughly in a warm place for several days before they were placed in the germinator. In Table 14 it is seen that at the end of 4 days 98 per cent had germinated in one case and 96 per cent in the other, and after 6 days 99 per cent of the first sample had germinated. This result is in accord with those obtained for red clover, where the beneficial effects of acid treatment of hard seed still obtain after the drying of the seed subsequent to treatment with acid and washing with water.

TABLE 14. SWEET CLOVER (*Melilotus alba*)

Effect of concentrated sulfuric acid (sp. gr. 1.84) on germination. 100 seeds used in each test

Lot no.	Treatment Soaked in	Number of seeds germinated after				Average of duplicate tests
		4 days	6 days	9 days	22 days	
1	Water 120 min	5	5	5	5	
2	Water 120 min	3	3	3	4	4.5
3	Conc. sulfuric acid 25 min	97	98	98	98(*b*)	
4	Conc. sulfuric acid 25 min	97	97	98	98(*b*)	98 (100 final)
5	Conc. sulfuric acid 60 min	98	98	98	99	
6	Conc. sulfuric acid 60 min	97	98	98	99	99
7	Conc. sulfuric acid 120 min. (*a*)	100	100	100	100	
8	Conc. sulfuric acid 120 min. (*a*)	98	98	98	98(*b*)	99 (100 final)

Effect of treatment with concentrated sulfuric acid (sp. gr. 1.84) for 30 minutes on the seed not germinated in the check lots above, after being in the germinator for 22 days

Lot no.	Number of seeds	Number germinated after		
		4 days	17 days	
1	93	91	91	(2 apparently alive at end of test)
2	95	91	92	(3 apparently alive at end of test)

Effect of drying out for 20 days after treatment with concentrated sulfuric acid for 1 hour and washing with water

Lot no.	Number germinated after		
	4 days	6 days	
A	98	99	
B	96	96	

(*a*) Seed coats somewhat injured (see text). (*b*) Six seeds left in these tests were treated with acid again for 30 minutes. At the end of four days these had all germinated.

With the foregoing results in mind, it is evident that for many samples of leguminous seed good results are obtained by the acid treatment. It seems possible to devise a method for the treatment of seed on a large scale: that is, seed which shows on testing that there is present a large amount of hard seed, may be treated by the bushel without any great difficulty and thus the germination may be increased.

WEED SEEDS

Various kinds of weed seeds are usually found mixed with the clover and alfalfa seeds of commerce. Some kinds of these seeds are similar in appearance to the commercial seeds, being thus difficult to distinguish or separate from them. Black medick and yellow trefoil are of this class. Other kinds can be easily distinguished in appearance but are difficult to remove. Of this class are the seeds of the dodders, plantains, docks, wild carrot, old-witch grass, daisies, and the like.

It was thought to be of interest and perhaps of value to determine the effect of concentrated sulfuric acid on these various weed seeds. In case they were killed by such treatment, those difficult to separate could then be done away with by this means. Accordingly tests were made, the results of which are shown in Table 15.

It is there seen that the seeds of black medick and of yellow trefoil are slightly injured by acid treatment, but even a treatment of two hours was not sufficient to kill more than three fourths of the seeds in any case. The acid treatment, then, is of no value in removing these seeds from commercial seed.

It is further seen in Table 15 that the germination of the seed of field dodder was hastened and increased by the acid treatment, the best germinations being here obtained after two hours in concentrated sulfuric acid. It is rather disappointing to find this to be true, since dodder is a very noxious weed. The seed of daisy, wild carrot, and bracted plantain were all killed by a 15-minute treatment with concentrated sulfuric acid. The seed of sorrel, curled dock, and old-witch grass, were all killed by a 60-minute treatment with concentrated sulfuric acid. These facts may be of some commercial importance.

COTTON SEED

While the effect of concentrated sulfuric acid on the seeds of legumes was being studied, the question arose of using acid for delinting cotton seed and then testing the germination. It was thought that if the seeds were not injured by the acid treatment they might be delinted in this way, so that they could be more readily separated into light and heavy seed and handled much more easily in planting.

TABLE 15. WEED SEEDS

Effect of concentrated sulfuric acid (sp. gr. 1.84) on some weed seeds found in commercial alfalfa and clover. 100 seeds used in each test

Name	No.	Treatment Soaked in	Number of seeds germinated after					(Total) 35 days
			5 days	9 days	12 days	17 days	22 days	
Medicago lupulina (Black medick)	1	Water 2 hrs.	18	33	33	34	35	35
	2	Water 2 hrs.	23	39	39	41	41	41
	3	Conc. sulfuric acid 15 min.	24	30	30	31	31	31
	4	Conc. sulfuric acid 15 min.	30	31	31	33	33	33
	5	Conc. sulfuric acid 1 hr.	22	22	22	23	23	23
	6	Conc. sulfuric acid 1 hr.	26	26	26	27	27	27
	7	Conc. sulfuric acid 2 hrs.	15	17	17	17	17	(*a*)17
	8	Conc. sulfuric acid 2 hrs.	7	10	10	11	11	11
Yellow trefoil	1	Water 2 hrs.	34	45	45	47	47	47
	2	Water 2 hrs.	28	39	39	39	39	39
	3	Conc. sulfuric acid 60 min.	31	35	35	35	35	35
	4	Conc. sulfuric acid 100 min.	25	29	29	29	29	29
Cuscuta arvensis (Field dodder)	1	Water 2 hrs.	0	0	0	0	1	1
	2	Water 2 hrs.	0	0	0	0	0	0
	3	Conc. sulfuric acid 15 min.	0	0	2	5	5	7
	4	Conc. sulfuric acid 15 min.	0	0	0	4	5	11
	5	Conc. sulfuric acid 1 hr.	0	14	25	26	27	31
	6	Conc. sulfuric acid 1 hr.	0	22	31	32	34	40
	7	Conc. sulfuric acid 2 hrs.	0	47	52	54	55	57
	8	Conc. sulfuric acid 2 hrs.	0	27	45	47	49	52

(*a*) Distinctly injured.

TABLE 15. WEED SEEDS — (*Continued*)

Name	No.	Treatment Soaked in	Number of seeds germinated after				(Total) 35 days
			9 days	12 days	17 days	30 days	
Plantago lanceolata	1	Water 2 hrs	18	18	25	34	34
(Rib grass)	2	Water 2 hrs	22	22	28	33	33
	3	Conc. sulfuric acid 15 min.	0	0	0	0	0
	4	Conc. sulfuric acid 15 min.	0	0	0	6	6
	5–6	Conc. sulfuric acid 1 hr.	0	0	0	0	0
	7–8	Conc. sulfuric acid 2 hrs.	0	0	0	0	0
Rumex acetosella	1	None	5	7	10	10	10
(Sorrel)	2	None	4	13	21	21	21
	3	Conc. sulfuric acid 15 min.	17	22	23	31	31
	4	Conc. sulfuric acid 15 min.	1	2	2	3	3
	5–6	Conc. sulfuric acid 1 hr.	0	0	0	0	0
	7–8	Conc. sulfuric acid 2 hrs.	0	0	0	0	0
Rumex crispus	2	None	4	8	33	53	53
(Curled dock)	3	Conc. sulfuric acid 15 min.	3	9	23	37	37
	4	Conc. sulfuric acid 15 min.	3	6	16	30	30
	5–6	Conc. sulfuric acid 1 hr.	0	0	0	0	0
	7–8	Conc. sulfuric acid 2 hrs.	0	0	0	0	0
Chrysanthemum leucanthemum	1	Water 2 hrs.	17	17	24	36	36
(Daisy)	2	Water 2 hrs.	11	13	16	22	22
	3	Conc. sulfuric acid 15 min.	(*a*) 1	1	1	1	1
	4	Conc. sulfuric acid 15 min.	0	0	0	0	0
	5–6	Conc. sulfuric acid 60 min.	0	0	0	0	0

(*a*) Distinctly injured.

TABLE 15. WEED SEEDS — (*Concluded*)

Name	No.	Treatment Soaked in	Number of seeds germinated after				(Total) 35 days
			9 days	12 days	17 days	30 days	
Daucus carota	1	None	41	44	45	45	45
(Wild carrot)	2	None	25	30	32	34	34
	3–8	Conc. sulfuric acid 15, 60, and 120 min	0	0	0	0	0
Panicum capillare	1	Water 2 hrs	0	0	0	6	6
(Old-witch grass)	2	Water 2 hrs	0	0	0	5	5
	3	Conc. sulfuric acid 15 min	0	0	0	4	4
	4	Conc. sulfuric acid 15 min	0	0	0	5	5
	5–6	Conc. sulfuric acid 60 min	0	0	0	0	0
Plantago aristata	1	None	5	10	42	69	69
(Bracted plantain)	2	None	7	20	52	78	78
	3	Conc. sulfuric acid 15 min	0	0	0	0	0
	4	Conc. sulfuric acid 15 min	0	0	0	0	0
	5	Conc. sulfuric acid 60 min	6	8	8	8	(*b*) 8
	6	Conc. sulfuric acid 60 min	0	0	0	1	(*b*) 1
	7	Conc. sulfuric acid 120 min	0	0	0	0	0
	8	Conc. sulfuric acid 120 min	0	0	0	0	0

(*b*) Probably escaped treatment.

Dr. H. J. Webber, on visiting a cotton-oil mill at Shreveport, La., found that the manufacturers were using sulfuric acid to delint their seed. It occurred to him that it might be feasible to delint seed for planting, and thus render possible the use of a machine like a corn planter. With this in mind he obtained some seed, compared the germination of it with that of some untreated seed, and found that the treated seed germinated earlier and better than did the check.

Effect of acid treatment on disease

It occurred to the writers that the acid treatment might have some effect on anthracnose, the germs of which are carried by the seed. While the germination experiments were being conducted there came to hand a bulletin from the Alabama Experiment Station, No. 153, by J. F. Duggar and E. T. Cauthen. In this bulletin the authors show the results obtained for different seed treatments for anthracnose. Sulfuric acid was among the treatments tried, the seed being treated for 5 to 8 minutes. The percentage of bolls attacked by boll rot for the checks or untreated seed was 10.6, while for the seed treated with sulfuric acid only 5.9 per cent of the bolls were attacked. Thus the injury due to anthracnose was practically diminished by half. It is possible that a longer treatment would have given better results.

Effect of acid treatment on viability

In order to test the efficiency of sulfuric acid in delinting cotton seed and the effect that such treatment would have on the viability of the seed, three lots of cotton seed were obtained for trial. Two of these lots were obtained from E. T. Coker, of Society Hill, S. C., one of which, designated as C 09, was of the crop of 1909; the other, designated as C 10, was of the crop of 1910. The history of the third lot, designated as C, is unknown, but it was similar to the other lots in appearance and in amount of lint attached to the seed.

It was found that the lint could be completely removed from the seed by treatment with concentrated sulfuric acid for about 30 minutes to 1 hour, and further tests showed conclusively that the viability was not injured by this treatment.

As shown by Table 16, the germination of cotton seed is accelerated and the total amount germinating (after 20 days) is considerably increased by the action of concentrated sulfuric acid for 15 minutes. The germination of the check tests, soaked in water for 15 minutes before being placed between blotters in order to compensate for the washings that the treated seed received, averaged 82.5 per cent at the end of 20 days. The average for the two lots soaked in concentrated sulfuric acid was 91.5 per cent,

TABLE 16. COTTON SEED

Effect of concentrated sulfuric acid (sp. gr. 1.84) on germination of cotton seed. 100 seeds used in each test. Tests made December, 1910

Lot no.	Treatment Soaked in	Number of seeds germinated after						Average of duplicate tests
		7 days	9 days	11 days	13 days	16 days	20 days	
C-x....	Water 15 min....	12	26	52	78	82	83	
C-y....	Water 15 min....	9	36	62	78	81	82	82.5
C-a....	Conc. sulfuric acid 15 min....	56	71	83	90	90	91	
C-b....	Conc. sulfuric acid 15 min....	54	70	84	88	92	92	91.5

or an increase of 9 per cent for the treatment. Nor was this the only advantage attained. The germination of the treated seed was accelerated very materially. At the end of 7 days, the time of the first count, an average of 55 per cent of the treated seeds had germinated, while in the check the average was 10.5 per cent. At the end of 9 days, the germinations were 70.5 per cent and 31 per cent, respectively; at 11 days, 83.5 per cent and 57 per cent, respectively.

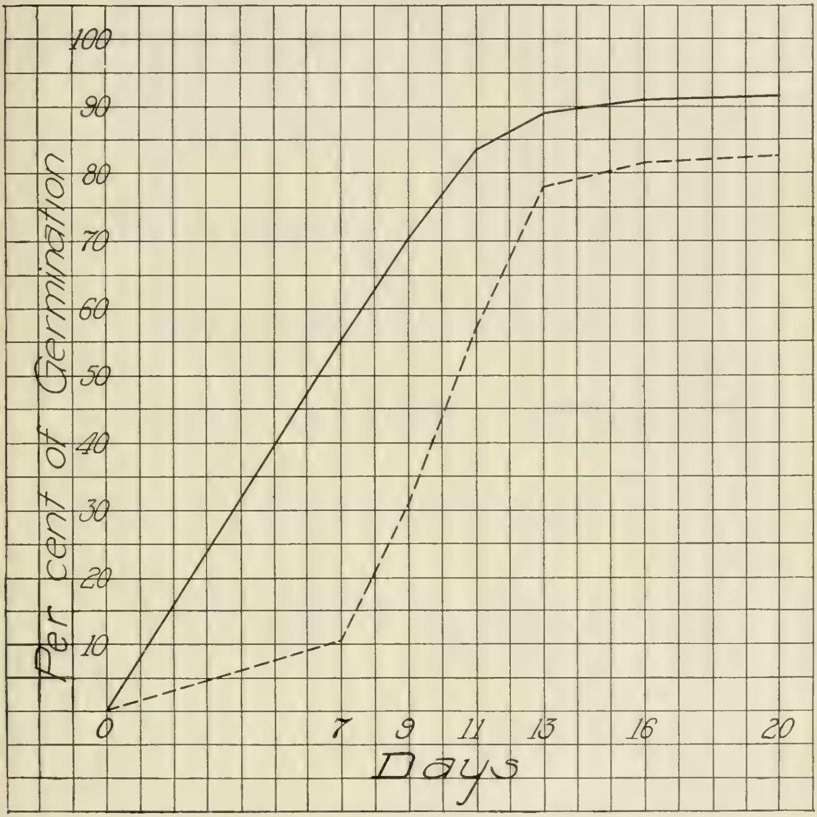

FIG. 82.—*The solid line represents the germination of cotton seed treated with concentrated sulfuric acid for 15 minutes; the broken line, the germination of the untreated seed.* (*Table 16*)

This acceleration of germination is illustrated in the accompanying curve, Fig. 82.

It is seen in Table 17 that Lot C 09 gave in the check tests 90 per cent and 97.5 per cent germination, the samples that were soaked in water for 24 hours previous to being placed in the germinator giving the lower germination. The acid-treated samples vary from 98 per cent to 87.5

TABLE 17. COTTON SEED

Effect of concentrated sulfuric acid (sp. gr. 1.83) on germination of cotton seed, crop of 1909. 100 seeds used in each case

Lot no.	Treatment Soaked in	Number of seeds germinated after								Average of duplicate tests
		4 days	6 days	8 days	10 days	12 days	17 days	23 days	27 days	
C 09–3	Water at 20–22° C., 24 hrs.	(a) 38	53	66	71	79	88	92	92	
–4	Water at 20–22° C., 24 hrs.	(a) 40	50	71	80	82	87	88	88	90
–5	Water at 20–22° C., 2 hrs.	10	39	60	69	81	95	97	99	
–6	Water at 20–22° C., 2 hrs.	5	43	63	76	85	92	94	96	97.5
–7	Conc. sulfuric acid 15 min.	10	43	65	74	81	93	94	94	
–8	Conc. sulfuric acid 15 min.	21	54	64	72	77	83	87	87	90.5
–9	Conc. sulfuric acid 30 min.	36	58	78	88	91	94	95	95	
–10	Conc. sulfuric acid 30 min.	54	69	77	83	88	92	93	94	94.5
–11	Conc. sulfuric acid 45 min.	55	77	83	86	90	97	97	97	
–12	Conc. sulfuric acid 45 min.	40	59	72	77	85	92	93	93	95
–13	Conc. sulfuric acid 60 min.	27	67	86	88	91	96	99	99	
–14	Conc. sulfuric acid 60 min.	30	70	88	92	93	96	97	97	98
–15	Conc. sulfuric acid 120 min.	54	74	86	87	91	92	93	93	
–16	Conc. sulfuric acid 120 min.	47	68	79	82	84	85	87	87	90
–17	Conc. sulfuric acid 180 min.	59	70	72	76	76	78	78	78	
–18	Conc. sulfuric acid 180 min.	75	85	89	93	94	97	97	97	87.5

(a) Four days from time put in germinator, five days from time first put to soak in water.

TABLE 18. Cotton Seed

Effect of concentrated sulfuric acid (sp. gr. 1.83) on germination of cotton seed, crop of 1910. 100 seeds used in each test

Lot no.	Treatment Soaked in	Number of seeds germinated after								Average of duplicate tests
		4 days	6 days	8 days	10 days	12 days	17 days	23 days	27 days	
C 10–3	Water at 20–22° C., 24 hrs.	(*a*)22	36	45	61	76	81	85	90	90
–5	Water at 20–22° C., 2 hrs.	0	5	33	61	76	88	91	91	
–6	Water at 20–22° C., 2 hrs.	1	16	41	61	90	97	100	100	95.5
–7	Conc. sulfuric acid 15 min.	10	34	47	64	77	88	94	95	
–8	Conc. sulfuric acid 15 min.	8	35	53	64	80	90	94	94	94.5
–9	Conc. sulfuric acid 30 min.	42	78	83	88	94	98	100	100	
–10	Conc. sulfuric acid 30 min.	30	63	81	85	87	91	91	91	95.5
–11	Conc. sulfuric acid 45 min.	10	40	65	82	87	93	95	95	
–12	Conc. sulfuric acid 45 min.	17	39	56	70	83	90	92	95	95
–13	Conc. sulfuric acid 60 min.	15	53	67	83	86	89	90	90	
–14	Conc. sulfuric acid 60 min.	21	50	75	88	94	97	97	97	93.5
–15	Conc. sulfuric acid 120 min.	49	76	84	92	92	95	99	99	
–16	Conc. sulfuric acid 120 min.	40	75	87	90	92	98	98	99	99
–17	Conc. sulfuric acid 180 min.	21	57	78	87	89	92	94	94	
–18	Conc. sulfuric acid 180 min.	43	86	93	96	97	97	98	98	96

(*a*) Four days from time put in germinator, five days from time first put to soak in water.

per cent, increasing from 90.5 per cent for the 15-minute treatment, through 94.5 per cent and 95 per cent for the 30-minute and 45-minute treatments respectively, to 98 per cent for the 60-minute treatment, and falling to 90 per cent and 87.5 per cent for the 120-minute and 180-minute treatments respectively. It is not believed, however, that the graduated increase and decrease in germination is of much significance.

It is seen in Table 18 that lot C 10 gave in the check tests 90 per cent and 95.5 per cent germination, the samples that were soaked in water for 24 hours previous to being placed in the germinator giving the lower germination. The acid-treated samples vary from 93.5 per cent to 99 per cent germination, the highest germination in this case being for the 120-minute treatment and the lowest for the 60-minute treatment. Germinations of 96 per cent, 95.5 per cent, 95 per cent, and 94.5 per cent, were secured for the 180-, 30-, 45-, and 15-minute treatments, respectively.

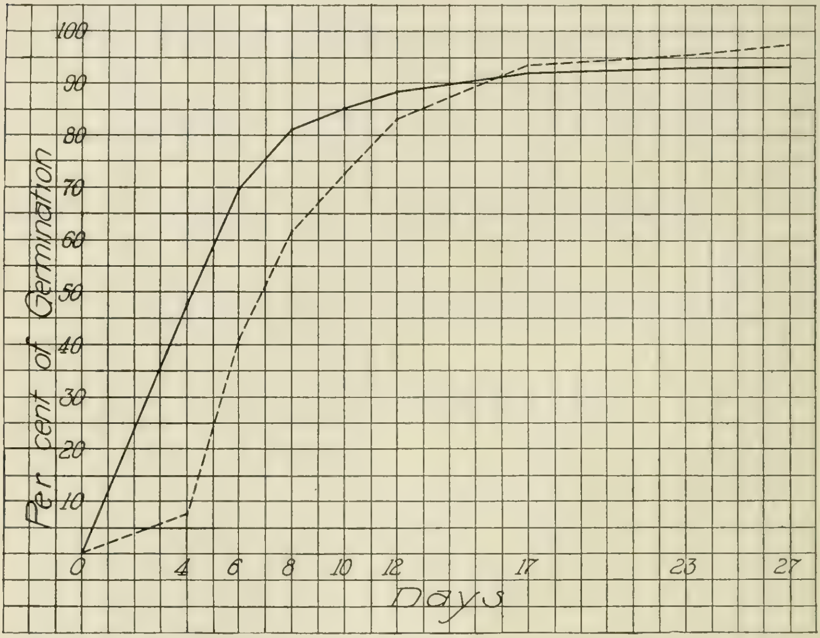

FIG. 83.—*The solid line represents the germination of cotton seed treated with concentrated sulfuric acid for 30 to 180 minutes; the broken line, the germination of the untreated seed. (Tables 17 and 19)*

In the tests with these lots the total germination of the acid-treated seed was about the same as that of the checks. The germination was markedly accelerated, however, by the acid treatment. The acceleration is represented graphically in Figs. 83 and 84, where the average germination of the check lots, or those germinated after being soaked in water for 2 hours, is shown in comparison with the treated lots. The treated lots include all acid treatments of 30 minutes or over, those treated 15 minutes not being included, since that time of treatment was considered insufficient. The acceleration of germination is quite marked in each lot.

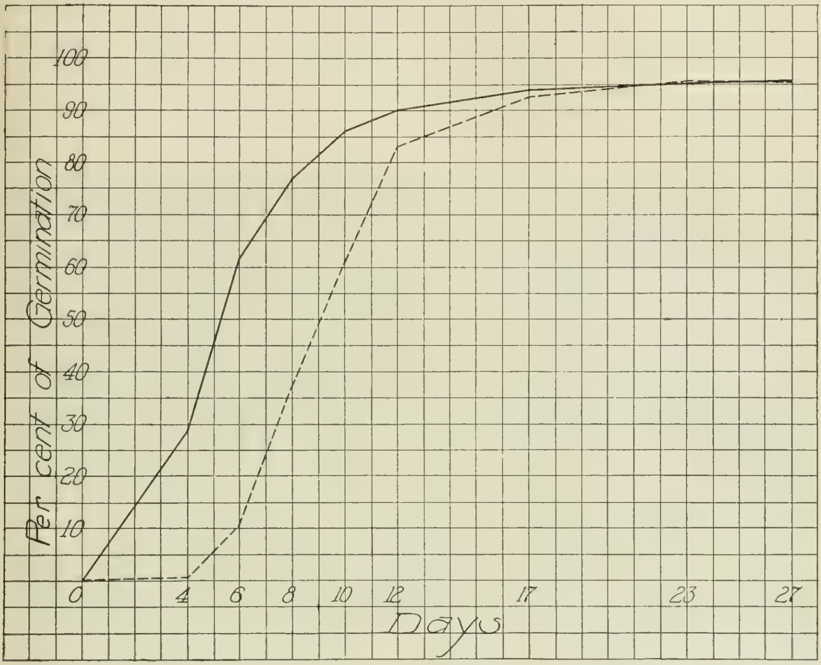

FIG. 84.—*The solid line represents the germination of cotton seed treated with concentrated sulfuric acid for 30 to 180 minutes; the broken line, the germination of the untreated seed.* (*Tables 18 and 19*)

TABLE 19. COTTON SEED

	Number of seeds germinated after							
	4 days	6 days	8 days	10 days	12 days	17 days	23 days	27 days
Lot C 09 treated..........	47.7	69.7	81.	85.2	88.3	91.9	92.9	93.
Lot C 09 untreated........	7.5	41.	61.5	72.5	83.	93.5	95.5	97.5
Difference in favor of treated	40.2	28.7	19.5	12.7	5.3	—1.6	—2.6	—4.5
Lot C 10 treated..........	28.8	61.7	76.9	86.1	90.1	94.	95.4	95.8
Lot C 10 untreated........	.5	10.5	37.	61.	83.	92.5	95.5	95.5
Difference in favor of treated	28.3	51.2	39.9	25.1	7.1	1.5	—.1	.3

The data given in Table 19 show the increased number germinated in the treated lots over the untreated lots. This is shown graphically by Figs. 83 and 84.

Effect of drying after acid treatment

The effect of drying the seed after it is treated with acid, and washed with water so as to remove the sulfuric acid, is shown in Table 20. It is seen that there is a considerable acceleration still manifest in the germination 28 days after treatment has taken place. In order to secure further evidence on this point, some of the C 10 seed that had been treated for 1 hour with sulfuric acid and then washed with water was tested after being kept in the laboratory for about 8 months. A check test of the untreated seed from the same lot, which had been kept in the meantime in the same room with the treated, was made for comparison. Of the untreated seeds 176 were used; of the treated, 116 seeds. The germinations after 4 days were: untreated, 42, or 23.9 per cent; treated, 112, or 96.6 per cent. Some of these seeds are shown in Fig. 85. It is believed that cotton seed can thus be delinted and allowed to dry out, and that the factors which cause acceleration of germination will still remain.

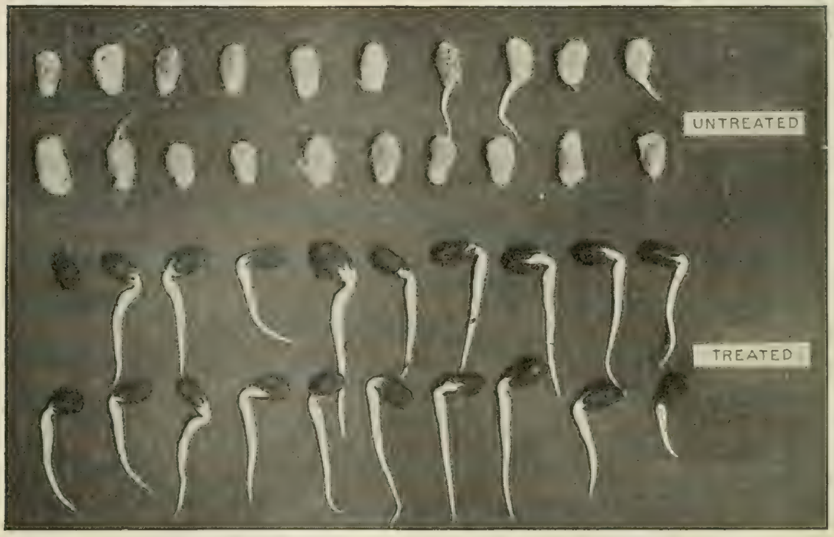

FIG. 85.—*Cotton seed. The lower twenty seeds were treated with concentrated sulfuric acid for 60 minutes. The twenty seeds above received no treatment. Germination after 4 days*

It seems evident that the advantages to be gained from delinting cotton seed are: the acceleration of germination secured; the increased facility with which the seed may be separated into light and heavy; the possi-

TABLE 20. COTTON SEED

Effect of concentrated sulfuric acid (sp. gr. 1.84), thorough washing with water, and subsequent drying out, on germination of cotton seed. 100 seeds used in each case. (Compare with Tables 17 and 18)

Lot no.	Treatment Soaked in	Dried days	Number of seeds germinated after							Average of duplicate tests
			6 days	8 days	11 days	13 days	16 days	22 days	27 days	
C 09-19	Conc. sulfuric acid 30 min., water 2 hrs.	28	27	67	70	73	76	77	80	
-20	Conc. sulfuric acid 30 min., water 2 hrs.	28	19	51	60	62	67	75	82	81
-21	Conc. sulfuric acid 75 min., water 2 hrs.	28	31	59	67	73	78	80	82	
-22	Conc. sulfuric acid 75 min., water 2 hrs.	28	32	62	71	72	73	77	81	81.5
C 10-19	Conc. sulfuric acid 45 min., water 2 hrs.	28	35	50	59	70	77	87	90	
-20	Conc. sulfuric acid 45 min., water 2 hrs.	28	34	54	64	68	77	84	90	90
-21	Conc. sulfuric acid 60 min., water 2 hrs.	28	45	64	71	78	86	94	97	
-22	Conc. sulfuric acid 60 min., water 2 hrs.	28	59	68	74	80	85	91	98	97.5

bility of using more improved machinery in planting; and the probable killing of anthracnose spores on the seed.

Since the clover seed was given a soil test, it was decided to do the same with cotton seed. With this in mind, two lots of about one gallon each were treated with acid, washed with water, and dried, and arrangements were made with E. T. Coker, Society Hill, S. C., to grow the seed together with some untreated seed of the same lots. This treated seed was planted in alternate rows with the untreated, and careful notes were kept by Mr. Coker. The seed was planted April 27, 1911, in very dry soil. On May 4 Mr. Coker reports, " Cotton cracking the ground, delinted seed showing most cracks on all rows "; and on May 5, " Cotton partly up, delinted seed showing most plants up for every row." On May 10 the hills up were counted, with the following results:

	Treated	Untreated
1909 seed	75	59
1910 seed	90	83

On June 8, a count of all plants, both 1909 and 1910, was made with the following results: treated, 521; untreated, 485.

There was no apparent difference in the vigor of the plants from either treated or untreated seed. Mr. Coker states that if the seed could be delinted on a large scale it would take less than half as much seed to plant an acre as it does at present.

SUMMARY

The results of the foregoing investigations may be summarized in the following manner:

1. Data have been given to show the increase in germination secured by treating red clover seed with concentrated sulfuric acid.
2. Similar results were obtained from sweet clover, alsike, Japan clover, alfalfa, and white clover.
3. The effect of the treatment was still apparent after the seed had been allowed to dry out before germination.
4. Many varieties of weed seeds commonly found in samples of clover or alfalfa seeds were killed by the acid treatment. The germination of other kinds of weed seeds was either benefited by the treatment or was not affected.
5. Cotton seed was easily delinted and the germination thereby increased and hastened by the acid treatment.

RECOMMENDATIONS

These recommendations are made for the benefit of any who may desire to treat seed with sulfuric acid:

Materials needed

The following materials are needed for treating seed with acid:

For clover or other small seeds in limited quantity:

Small homeopathic vials or test tubes that will hold the seed easily and will give plenty of room for mixing with the acid.

Concentrated sulfuric acid, of a specific gravity of about 1.84, and receptacles for same. Either the chemically pure acid or the ordinary dark-colored commercial acid gives the same results.

A needle mounted on a wooden handle, to be used for stirring the acid and seed.

A spatula or section lifter is needed to remove seeds from the strainer and place them into the tubes.

A wire tea-strainer of fine mesh. This will resist the action of the acid for several hundred tests.

Blotters and germinator, or other apparatus for germinating seeds, if the seed is not to be planted in the soil.

For clover or other small seeds in large quantities of a half peck or more:

Stone jars of two or three gallons capacity, or larger.

Acid as above.

A wooden or iron stirring-rod. A broomstick is satisfactory.

A strainer made by nailing a fine-mesh iron, copper, or brass screen to a wooden box.

For cotton and larger seeds:

The same apparatus as given above may be used, except that the screen or sieve may be of larger mesh.

Methods

In order to determine whether acid treatment of leguminous seeds is necessary, a germination test should be made. If this shows a low percentage of germination and a large amount of hard seeds that are apparently alive, acid treatment will probably be beneficial. The methods of treatment advised are as follows:

For limited quantities of seed:

When there is only a small amount of seed to be treated, such as the seed from a single head of clover or from a single clover plant, amounting to not more than a few hundred seeds, the following method may be employed:

Place the seed in a small homeopathic vial or test tube. Pour on the seed a quantity of concentrated sulfuric acid equal to about five or six times the volume of the seed. Stir the mixture thoroughly with a stirring rod until all seeds are completely coated with the acid. Allow to stand for 15 to 45 minutes at ordinary room temperature, the longer time being necessary if the percentage of hard seed is high. At the end of this time allow water from a faucet to run into the vial or test tube until it is nearly full, then quickly pour the entire contents into the strainer and wash quickly with water. (If this method is followed it should be done over a porcelain or other acid-resistant sink, and the waste acid washed away with water.) Wash for five minutes in running water or until the seed is entirely free from acid. The seed may be planted immediately or it may be allowed to dry before planting, the former process being preferable for small lots of seed.

For seed in large quantities of one half peck or more:

For larger amounts of seed for sowing in fields the following modifications make the above method applicable:

A stone jar of two or three gallons capacity, or larger, may be used as a receptacle in which to mix the seed and the acid, and a wooden or iron stick (a broomstick is satisfactory) may be used for stirring. The acid may be washed off by pouring the seed and acid into a wooden box whose bottom has been replaced by a screen of proper mesh. After draining a few minutes, water should be poured over the seed, in large amounts at first in order to prevent heating, and this process should be continued until all acid is washed away. For larger amounts of seed, which is to be sown in a seeder, it will be necessary to allow the seed to dry before sowing. This may be accomplished by spreading it out on a floor, or other suitable place, in a thin layer.

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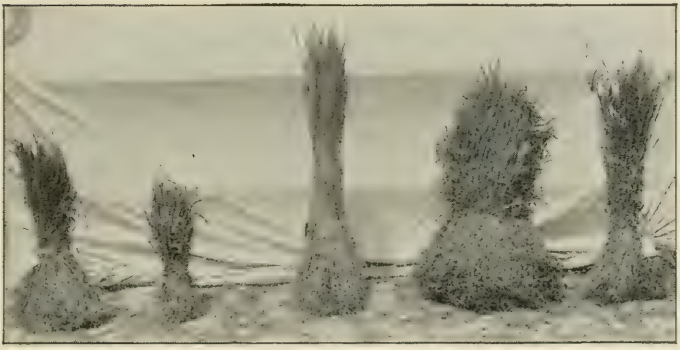
CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Plant-Breeding

THE PRODUCTION OF NEW AND IMPROVED VARIETIES OF TIMOTHY



Comparative yields of different races of timothy

BY HERBERT J. WEBBER

WITH THE COLLABORATION OF
THOMAS F. HUNT, JOHN W. GILMORE, CHARLES F. CLARK, AND
SAMUEL FRASER

ITHACA, N. Y.
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THE PRODUCTION OF NEW AND IMPROVED VARIETIES OF TIMOTHY*

Herbert J. Webber

For several years a somewhat extensive series of experiments in the breeding of timothy has been conducted by the Cornell University Agricultural Experiment Station. These experiments have now advanced to such a stage of completion that certain conclusions can be drawn regarding the methods of investigation that can best be followed in such experiments with timothy, and some idea can also be obtained of the probable value of the results to be achieved. It is thought best at this time to publish a preliminary paper describing the most important practical results obtained and outlining the methods of experimentation used.

A very large number of variations have been cultivated and studied in the course of the experiments and a mass of data has been accumulated on yields and other characters in different seasons; but the presentation of such data will be retained mainly for a future publication, when a complete report of the investigations can be made.

HISTORY OF EXPERIMENTS

The Cornell experiments in breeding timothy were started in 1903 under the direction of Professor T. F. Hunt, who was assisted at first by Professor J. W. Gilmore and Samuel Fraser. In 1906 Mr. Fraser, who had charge of the field cultivations, resigned and his place was filled by Dr. C. F. Clark. The writer was placed in charge of the experiments in the spring of 1907, and from that time until 1910 he was assisted in the work by Doctor Clark.

Extensive notes on the large number of individuals grown were made each year from 1905 to 1907 by Mr. Fraser and Doctor Clark, assisted by H. W. Teeter: such notes including yields, height of plant, time of blooming, duration of blooming period, and the like. These notes, covering the variations in these characters for the same plants in different seasons, have been brought together by Doctor Clark in an excellent monograph, "Variation and Correlation in Timothy," published as Bulletin 279 of this station. This monograph is a scientific study of the variations and is not suited for general distribution, so that a short discussion of the different types of variations observed will be given later in this bulletin.

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* Paper No. 28, Department of Plant-Breeding, Cornell University, Ithaca, New York.

When the writer took charge of the experiments in the spring of 1907, a large number of plants grown from seed obtained in various parts of the United States and in foreign countries were under cultivation. These plants were all two to five years of age, were in prime condition for study, and furnished abundant opportunity for making selections of different types as there were about 17,000 individuals. The writer's first task was to study these numerous plants and determine the types that were most likely to prove valuable for general cultivation, also those of greatest interest scientifically, as showing the range of variation exhibited by timothy in its present stage of evolution. Extensive notes regarding the yield of these plants had been taken during previous years but were not compiled and summarized, and the selections were thus made on the evidence that the writer could derive from a study and comparison of the plants in the field. Over two hundred different types were selected for further trial as representing interesting characters from a scientific or practical standpoint. More types were selected from this mass of material in the summer of 1908, but the types selected in 1907 have formed the basis of the further experiments.

Notes were again made in 1907 on all the plants of the early plantings, and these notes, with those previously taken, formed the material utilized by Doctor Clark in his bulletin on " Variation and Correlation in Timothy," which was brought together and published in 1910. Had it been possible to make this summary of the variations earlier in the development of the experiments, it would have been a very valuable guide in making the choice of types for the continuation of the work; but it is probable, nevertheless, that the majority of the valuable types were secured by the careful field studies.

In his work in connection with these experiments the writer was ably assisted throughout the experiments by his head gardener, H. W. Teeter. He is also indebted to his associates, Professors H. H. Love and A. W. Gilbert, for many valuable suggestions and for the direction of the work in his absence from home at various periods.

TIMOTHY AS AN AGRICULTURAL CROP

Timothy, scientifically known as *Phleum pratense* Linn., is one of the true grasses. It is said to have been introduced into Maryland from Europe, where it is native, by Timothy Hansen about the year 1720; thus the name " timothy," which is most generally recognized for the grass in cultivation. It is also frequently known as Herd's grass, from a man named Herd who is said to have found it growing wild in New Hampshire and begun its cultivation. Timothy has thus been in cultivation in this country for nearly two centuries. It is more extensively grown as a hay crop throughout the northern United States than is any other plant. It has also been cultivated for a long period in certain parts of Europe, but is not used so extensively there as in this country.

Unlike the majority of our extensively cultivated crops, timothy has not been improved by the segregation of different varieties or races. Almost all our cultivated plants and animals are represented by numerous varieties and breeds. We do not cultivate simply wheat, corn, or apples, but we grow Dawson's Golden Chaff wheat, Leaming corn, or Baldwin apples. We have hundreds of different races and varieties of these crops that have been bred and selected because of their superior qualities and fitness or their adaptability to certain soil or climatic conditions. It is well recognized that different varieties of cultivated plants differ in their adaptability to various soils, yet when we buy timothy for planting we buy simply timothy seed, and not any special variety of known origin and value. We know nothing of its special fitness for our farms and climate other than that in general timothy does well in our State. If we ask for selected seed, what we get is simply seed that has been specially cleaned and winnowed or is from a particularly well-cured crop. It is clear that such procedure is contrary to the well-known principles of agriculture, and if we desire to secure the best possible crops of hay we must plant improved varieties adapted to our conditions.

Hay is the most extensively grown crop in the State of New York, and the great bulk of our hay crop is made up of timothy. At present no crop means so much to the farmers of New York as timothy, and yet timothy remains unimproved. This thought was clear in the minds of the experiment station authorities when investigations in the breeding of timothy were inaugurated.

Previous to the beginning of the Cornell experiments, little work had been undertaken in breeding timothy. Professor Hays,* at the Minnesota Experiment Station, had made some studies of the variations but no improved varieties were introduced. Somewhat later, in 1894, Dr. A. D. Hopkins,† of the West Virginia Experiment Station, made selections of a number of different types observed in nature and tested their comparative yielding powers. He obtained several different varieties, which were placed with the United States Department of Agriculture for comparative trial and distribution. These varieties have been under trial by the Department for several years but have not been generally distributed. These two attempts, so far as the writer is informed, comprise all the work on breeding timothy that had been undertaken in the United States prior to the beginning of the Cornell experiments.

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* Hays, W. M. Minnesota Experiment Station Bulletin No. 20 (1892).

† Hopkins, A. D. Proceedings of the Society for the Promotion of Agricultural Science. 1895. Pp 29–33.

It is clear that the most important problem before hay growers to-day is to secure improved varieties that are known to be adapted to local conditions and fitted to give the best quality and yields of hay under these conditions. Not until good varieties adapted to various regions have been secured can we expect any very general improvement and increase in the hay crop of the State or of the country.

METHODS USED IN THE CORNELL EXPERIMENTS

During its many years of cultivation over extensive areas in various parts of the world, timothy has been subjected to widely varying conditions of climate and of soil, and if different environmental conditions tend to cause or induce variations we should expect to find in timothy a wide range of variations. In starting to improve any plant, the first step in the investigation is to collect the known varieties and as many different variations as can be found, and test them comparatively under the environmental conditions where our experiments are to be conducted. This is done in order to learn which ones are best suited to the particular conditions of environment with which we are concerned. Timothy has not been segregated into varieties, and the first stage of the breeding investigation becomes thus the collection of as many variations as possible. The problem of the breeder here is to determine what different characters have been originated in the plant in the course of its cultivation, and then to find individual plants in which those characters that are most desirable are combined. If such plants cannot be found already in existence, the breeder must resort to hybridization in order to obtain the combination of characters desired.

In starting the Cornell experiments with timothy, in order to determine the range of variation and to procure material from which a selection of types could be made, timothy seed was obtained from a large number of places in the United States, Canada, and foreign countries. The various sources from which seed was obtained and the number of samples from each State or country were as follows:

United States:	
New York	93
Wisconsin	16
Ohio	14
Pennsylvania	14
Michigan	6
Maine	3
Connecticut	2
Delaware	1

District of Columbia	1
Illinois	1
Indiana	1
Iowa	1
Kansas	1
Maryland	1
Massachusetts	1
Missouri	1
New Hampshire	1
New Jersey	1
South Dakota	1
Vermont	1
Virginia	1
West Virginia	1
Total from the United States	163
Foreign countries:	
Austria	10
Canada	7
Denmark	1
England	5
Germany	9
Hungary	3
Ireland	1
Norway	4
Scotland	2
Sweden	15
Switzerland	3
Total from foreign countries	60

The seed from the different sources was germinated in sterilized soil and the plants were grown in small pots in a greenhouse until they had reached sufficient size to be transplanted to the field. These first plants were planted in the field in the fall of 1903, forty-two plants from each lot of seed being grown. In each case these were planted in plats of two rows each, the individual plants being three feet apart each way. Every third plat of two rows was planted as a check plat with timothy seed from the Cornell farm. By setting the plants in rows some distance apart, much expense can be saved in their cultivation by the use of horse cultivators. In the course of the experiments several distances of planting have been tried. The most convenient arrangement tested was that in which the rows were placed four feet apart and the plants three feet apart in the rows.

The best time to transplant young plants to the field at Ithaca is in the fall, preferably between the 10th and the 20th of September. By this time, seeds from selected plants, if planted immediately following the harvest, will have produced seedlings of sufficient size so that they may be safely transplanted. When transplanted the young plants should have two to four leaves, each three or four inches long.

The best known method of handling the seed of select plants is to plant them in flats or small shallow boxes about two feet long, eighteen inches wide, and three inches deep. The sterilized soil is placed in these flats and the seed sown rather shallow, about one fourth of an inch deep, in rows about two inches apart. When the seed is well up the plants can be thinned out in the rows and left with a space of about an inch between them. By this treatment the seedlings may be grown continuously in the same flats until transplanted to the field. The soil used in growing the seedlings should contain enough well-rotted and pulverized manure to keep the young plants growing vigorously for a period of six weeks or two months preceding the transplanting to the field.

It has been found desirable to transplant to the field rather early in September, as it is important that the young plants should have opportunity to get well rooted before the weather becomes too cold for growth.

Young seedlings transplanted in the fall do not produce a very large yield the following season, but even the first summer gives an indication of the rapidity of growth and comparative vigor of the different plants. They must be followed through four or five different seasons, at least, in order to obtain a definite judgment of their comparative value.

In the first lot of plants grown from seed obtained from the different sources, there were 298 plats of forty-two plants each, or a total of 12,516 plants. This number was gradually reduced by the death or accidental destruction of some plants (Plate I).

In the summer of 1905 a certain number of plants were chosen as representing the extremes of certain characters, and open fertilized seed from these plants was saved and planted. The characters considered in this lot of plants were:

Heavy yield and light yield.
Vigor good and vigor poor.
Coarse stems and fine stems.
Early bloom and late bloom.
Short, fine heads and long, fine heads.
Thick heads and thin heads.

Dark nodes and light nodes.
Panicled heads and simple heads.
Tall plants and short plants.
Broad leaves and narrow leaves.
Dense habit and spreading open habit.

Of this planting there were 147 plats, each plat containing two rows of sixteen plants each. The whole planting thus contained at first 4,704 plants, but many of them died, so that this number was soon greatly reduced. When the writer made his first observation in 1907 these plants were producing their second crop, while those of the first planting were producing their fourth crop. Thus they were all of suitable age to show their characteristics well and the different characters and character combinations could be studied to advantage. Some of the variations will be described briefly under the next heading.

VARIATIONS IN TIMOTHY

(See Plates II to V)

Size and form of plant.— The most striking difference observed on a casual examination of a number of timothy plants is in the size of different individuals. Some are very tall and some very short and all gradations in size between these two extremes can be found. They range in height from about fifteen inches to fifty-five inches, with an average height of about thirty-eight inches. This difference is further exaggerated by the variation in thickness of various plants. Plants two years old and grown side by side may form clumps varying in thickness from four inches to eighteen inches, due to the variation in stooling power of the different plants (compare Plate III, Fig. 4, and Plate V, Fig. 4). Some plants stool abundantly and form numerous culms; others are lacking in vigor and form only a few stools and thus develop only a few culms, resulting in a plant of small size. In the same way and for the same reason the number of culms varies greatly in different plants, varying in plants two or three years old from a half dozen up to two hundred and fifty or more. Plants of the same diameter may also vary greatly in number of culms, giving with few culms an open plant (Plate II, Figs. 1, 6, and 7) and with many culms a very dense plant (Plate II, Figs. 3 and 4).

The above factors taken together are those that, primarily, make up the variation in weight or in yield of hay. Plants of low stature and small diameter, with few culms and open, have a low yield; while those that are tall and large in diameter, with many culms and dense, give large yields.

Yield is thus dependent on several distinct characters that are doubtless inherited separately. Indeed, many more factors than the above are concerned in determining the yield.

Another important type of variation is found in the direction of growth of the culms. In some plants they grow strictly erect (Plate III, Figs. 4 and 6), while in other cases they bend strongly outward from the base (Plate III, Fig. 3). All degrees of variation between these two types can be found in different individuals. In some cases the culms bend at the nodes, becoming markedly angular and producing an irregular, scraggly plant. This is so marked a character in some plants that practically every culm bends outward and finally lies prostrate on the ground, not by the breaking of the stem, but by the gradual bending outward. This forms the so-called " lodging plants," which are in some cases very marked types (Plate III, Fig. 1).

Culms and nodes.— The culms or stems of different plants vary in height and number as indicated above, but they also vary in diameter: some being thick and large, thus forming coarse hay, and others being slender, forming fine hay. The range in variation is naturally very great on the same plant, but on some fine-stemmed plants the average diameter of the culms is less than two millimeters, while on other plants the average diameter is over three millimeters. The diameter of stem does not seem necessarily to be correlated with height, as many tall plants have comparatively small stems.

A difference of opinion exists among growers and dealers in hay as to the size of stems desired in a good type of hay. Hay dealers because of the market demands, usually prefer a rather coarse-stemmed hay, while most farmers with whom the writer has consulted are inclined to prefer fine stems. The true comparative value of coarse-stemmed and fine-stemmed types can be determined only by nutrition and digestion analyses and experiments, but it would seem reasonable to suppose that coarse stems of the same height would be likely to contain less woody fiber, comparatively, than would an equal weight of fine stems. The fine stems, in order to be sufficiently strong and rigid to remain erect, would probably require more woody tissue.

The number of nodes is commonly five and this number very strongly predominates; but even on plants having mainly five nodes, usually a few culms will have three or four nodes and others six nodes. Occasionally a plant is found on which four nodes predominate, and more rarely one that has six to eight nodes per culm.

Considerable variation is also found in the length of the different internodes. Usually the lower internodes are short, the middle ones longer, and the uppermost very long; but here, as in other characters, there is great variability and individual plants usually have the same general type in all culms.

The character of the basal nodes, bulbs, and method of stooling is illustrated in Fig. 86. When the lower nodes are long, as in *e*, the leaves are likely to extend higher on the stem than when the lower nodes are short, as in *b*, *c*, and *d*. There is considerable variation in the size of bulbs formed by different plants, but this character has not been given special attention in the Cornell experiments.

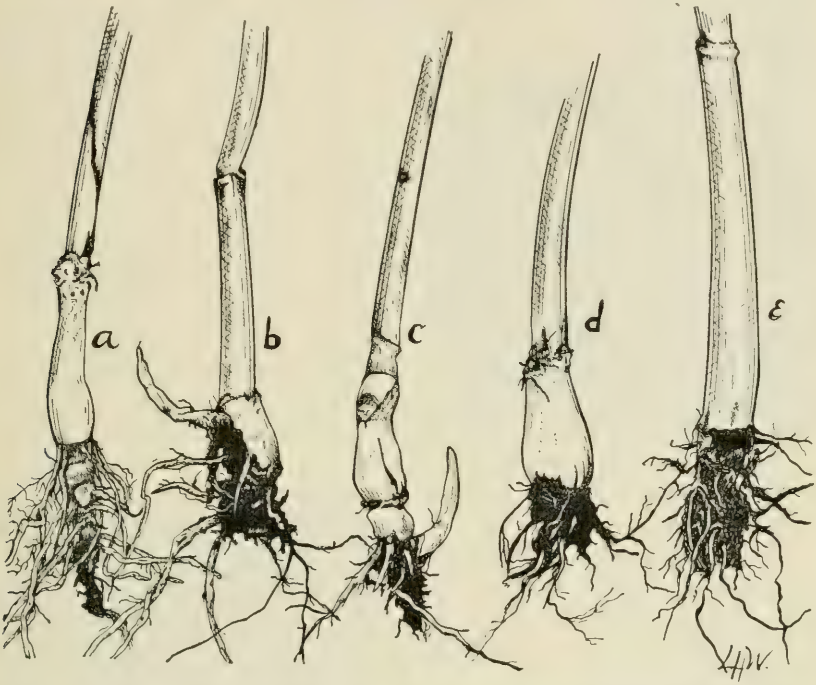

FIG. 86.—*Bases of culms showing the bulb development and variation in length of lower internode*

The nodes in some plants are dark purple or nearly black, and in others they are green, like the remainder of the stem, or light yellowish green. Various ranges between these two colors are exhibited by different plants, and the width of the colored band around the node may also vary greatly. The color of the nodes is independent of the color of the stems and the other parts of the plant. While in the majority of the plants the general color of stems and leaves before ripening is some shade of green, in some plants the stems and parts of the leaves are purplish or reddish. In a few cases this color becomes quite general throughout the plant, showing particularly on the stems, nodes, and glumes, and also to some extent on the leaves.

Another peculiar character, of no interest from an economic standpoint, is the tendency of some plants to have the stem wavy for an inch or two below the head.

Leaf characters.— The number of leaves per culm corresponds to and varies in accordance with the number of nodes, although the leaf from the first node may decay early and in any case is too low to form a part of the crop cut for hay. The bases of the leaves sheathe the stem for some distance above the node, and the length of this leaf sheath varies considerably on different plants. In some plants in which the upper internode is short and the leaf sheath long, the head remains, even when mature, partially inclosed in the upper leaf-sheath. In other cases the upper internodes may be very long and the leaf sheath short, when the base of the head may be eight to twelve inches above the last leaf, leaving the upper part of the plant largely leafless. This character gives rise to two types of plants, which, in extreme cases, are very markedly different in appearance. When the upper internode is very long and the lower internodes short, the leaves have the appearance of being clustered at the base (Plate IV, Fig. 4); while those plants that have comparatively short upper internodes and longer lower internodes have the leaves extending well to the top of the plant, giving the appearance of a leafy type (Plate III, Fig. 6). Which of these characters is the more desirable in a hay type may be questioned, but it would seem from the writer's observations that the plant which is tall but has the leaves extending well to the top of the culms is much to be preferred. The more the leaves are clustered at the base, the more likely they seem to become mildewed or rusted and to dry up and fall off early, or to become worthless as hay. It would seem very desirable to have the leaves borne as high on the stems as possible. The writer thinks, therefore, that this is an important point to bear in mind in choosing plants of ideal type.

The leaves also vary greatly in length and in breadth, some plants having long leaves and others short, some having narrow leaves and others broad. The broadest leaves are usually comparatively short and the plant with the largest leaf surface is apparently one with moderately broad, long leaves. The plants giving the largest yields of the best hay apparently do not ordinarily represent either extremes of length or width of leaf. The leaves on different plants may be more or less rigid or flaccid, may stand nearly erect and close to the stem or bend outward and become reflexed, may remain flat or be more or less rolled up; but these are characters that apparently have little relation to the value of a type for practical purposes and they can probably be disregarded in choosing plants in selection work.

Head characters.— In timothy, as in wheat and oats, wide variation is found in the head characters. The most noticeable of these are the variations in length and in thickness, but the heads also vary in form of apex and of base. The following are the main characters that show variation, and in each of the characters several grades of intermediates may occur: The heads may be long or short (Fig. 87), thick or thin (Fig. 88), dense or lax, greenish or purplish in color before mature, gray or tawny in color when ripe, simple or branched (panicled or barbed), erect or nodding, and continuous or interrupted. The apex and base of the head may be either blunt or pointed (Figs. 89 and 90). A blunt apex and base give a cylindrical head; a pointed apex and base give a fusiform head; a blunt base and pointed apex give a conical head; a pointed base and blunt apex give a clavate or club-shaped head.

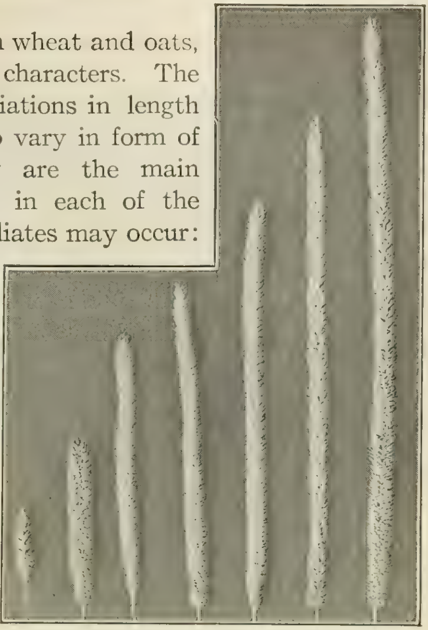

FIG. 87.—*Variation in length of head*

All these shape characters of the head are presented in many degrees, so that the shape and size of head show an almost infinite number of forms. Of rather special interest are the panicled head and the interrupted head. The panicled head (Plate V, Fig. 3) is not uncommon and has been bred into a pure race. In this form, which has also been called barbed, or branched, the rachis, or main axis of the head, is distinctly branched. In the interrupted head a space of greater or less extent in the middle portion of the rachis remains bare, failing to develop spikelets. This peculiar character, which would seem to

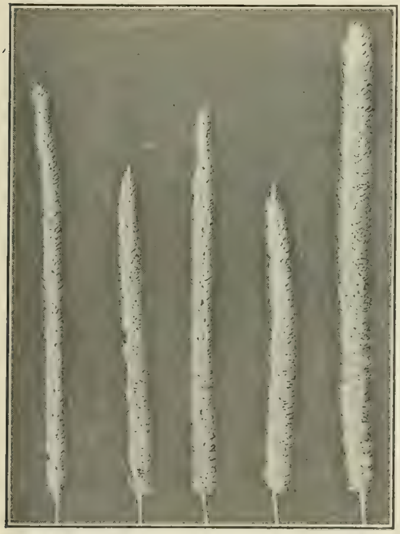

FIG. 88.—*Variation in thickness of head*

be due to disease or to accidental injury, is apparently a heritable character.

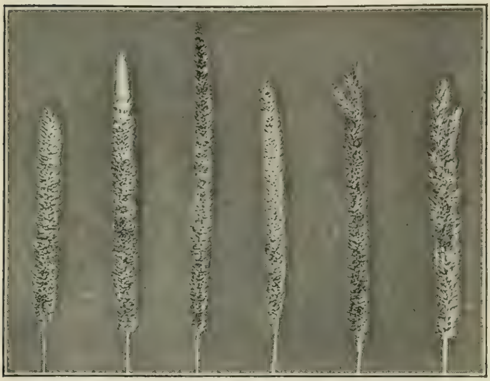

FIG. 89.— *Variation in apex of head*

Many other differences of characters would doubtless be found in parts of the head, such as narrow and broad glumes, but they would probably be of no value economically other than for the differentiation of varieties. Indeed, the head characters as a whole are apparently of little importance from the breeding standpoint, other than as distinguishing varieties or races. The main factor of interest is found in the relation of the size of head to seed production. A large head is necessary if large seed production is desired, and a medium-sized head if medium seed production is desired. The relation of the amount of seed produced to the relative yield of hay, the relative yield of nutrients, and the relative yield of digestible nutrients per acre, must be determined before a definite policy can be formulated with reference to the size of head that the best type of timothy should have. No data on this subject are yet available, so far as the writer is informed.

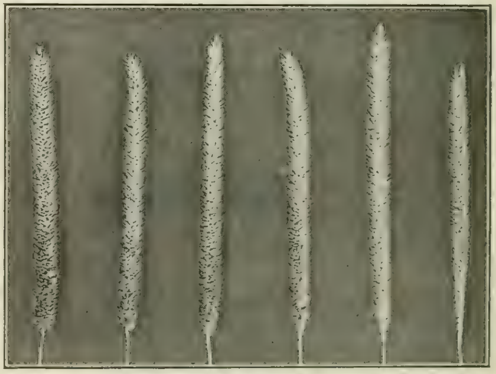

FIG. 90.— *Variation in base of head*

In general, the writer has assumed that in a hay and forage crop of this nature it is desirable to have the nutrients largely distributed in the stems and leaves, rather than concentrated in the seeds. If the nutrients are confined largely to the seeds and these ripen, considerable numbers of them may pass through the animal undigested and thus be lost. Should we favor the concentration of the nutrients in the seed by selecting types giving large yields of seed, we should probably lessen thereby the relative amount of nutrients in the stems and leaves. This problem must be thoroughly investigated chemically and by nutrition experiments before any reliable judgment can be reached. In the absence of such information the writer believes it to be the best policy to direct the selections toward the production of types giving only a medium seed production and a large yield of hay of good quality. This would mean, in general, that we should select types with medium-sized heads.

It will be interesting to note further in this connection that there is a considerable range of variation in the size of seeds, many plants giving seeds fully twice as large as those of other plants. It is also well known that in threshing some of the seeds come out naked, the glumes having been removed. A wide variation in this character is also noticeable in different plants. In some individuals the glumes invest the seed very firmly and practically all the seeds remain covered with the hulls; in other plants the glumes seem to be easily removable and a large proportion of the seed threshes out hull-less, or naked.

It would seem that of varieties giving the same yield of seed a large-seeded type would be preferable, as a larger quantity of stored nutrition to start the young plant would probably give a stronger plant. But here, again, further experiments are necessary before a definite conclusion can be stated.

As to the importance of securing hulled or hull-less seeded types, no positive statement can be made. The general opinion prevails among timothy dealers that hulled seed is to be preferred, for the reason that seed covered with hulls is supposed to retain moisture better and thus protect the germ from drying out immediately after seeding and during germination. In our own experiments several one-fortieth-acre plats sown in the fall of 1911 with hulled and hull-less seed gave, to all appearances, equally good germination and apparently equally good plants. No crop has yet been harvested from these plats, so that the final comparison cannot yet be given.

Season of blooming and maturity.— In the season of blooming and maturity, wide variation is found in different plants. A difference in time of blooming of fifteen to eighteen days was found to be exhibited by different plants, and varieties of about this degree of difference can doubtless be produced. Indeed, some of the varieties already produced in the Cornell experiments differ almost as much as this in their season of blooming. The time of blooming is of the greatest importance in a practical way and, in general, indicates the period of maturing. The time of cutting is largely gauged by the period of blooming, as it should begin immediately following the close of bloom if the best yield and quality of hay are to be obtained (see appendix to this bulletin). It is important to have varieties of timothy differing in season of blooming and maturing, in order that the farmer may use early, medium, and late varieties and thereby have different fields maturing at different times. In this way he may extend his harvest over a longer period and still have his entire crop harvested at the proper period of maturity. In bad harvest seasons, when the acreage grown is extensive this may be very important.

A feature of the season of maturing, distinct from the ripening of the seed, is found in the difference of time exhibited by some plants in maturing the leaves and stems. Probably in the majority of plants, the leaves and stems are considerably dried up and discolored by the time the seed is ripe, all parts of the plant apparently maturing at the same time. In other and apparently rarer cases, the foliage and stems remain green and fresh, retaining their ability to function in assimilation, until the heads are dry and the seeds are fully mature. Such types, in our experiments, have come to be known as "green leaf types." This green leaf character would seem to be very valuable in a hay type of plant, as such plants apparently retain their good quality and digestibility much longer than do those plants that dry up early.

Rust resistance.— One of the very interesting discoveries made in connection with the Cornell experiments is that different timothy plants show great variation in their susceptibility to rust (*Puccinia graminis*). Rust on timothy has not been generally known as a serious malady, but one of the first observations made by the writer in 1907 was the very great abundance of rust on the experimental plats. This led to extended observations and the malady was found to be abundant throughout the State. Correspondence brought out the fact that it was also abundant in Pennsylvania, the District of Columbia, and Indiana. Observations made every year for the last five years in various parts of the State have shown that rust is the most serious disease affecting timothy. The variation of different plants in their susceptibility to rust indicates the probability of securing strains resistant to the disease, and all selections of practical types are made with this in view. Indeed, where rust is so abundant as it has become in New York during the last five years, a heavy-yielding sort is likely at the same time to be largely resistant to rust (Plate V, Figs. 1 and 2).

It seems probable, from our experience, that rust-resistant types of almost all forms of plants can be obtained.

Variations in rapidity of growth.— Another interesting factor is the rapidity of growth of different individuals. Many plants reach their highest yield in the second year and decline thereafter, while other plants do not reach their greatest yield until the fourth or fifth crop year. Apparently those of rapid growth soon die, while those of slower growth are longer-lived. How long timothy plants will live when cultivated as individuals is not fully known, but a number of plants in our experiments are now eight years old and many still appear vigorous.

This variation in rapidity of growth suggests the advisability of securing short-lived, quick-growing varieties for special use in short rotations, and other slower-growing types for permanent meadows.

Variations in stooling.— The marked variation of different plants in their ability to stool, or spread by underground shoots, suggests the possibility of securing plants that normally propagate by underground stems, suitable for use as pasture types. The majority of the varieties stool too near the surface of the ground and are too greatly injured by the trampling of stock to form satisfactory pasture types. It is probable that types stooling abundantly and rather deeply could be selected, which would be far superior to ordinary timothy for pastures. In our experiments, only slight attention has thus far been given to this problem.

TYPES OF TIMOTHY VARIETIES DESIRED

From the above discussion of variations observed in timothy, it will have become evident to the reader that almost any type of timothy desired can probably be found or produced by careful breeding, as almost every character presents numerous variations. In starting the selections a careful study of the variation was made in order to determine the combination of characters that a good type should possess. It was desired primarily to secure early, medium, and late hay types that would be good yielders. Any perfect plant of these three types, in order to be best suited to the purpose, should necessarily possess the following characters as nearly in the maximum degree exhibited as could be found combined in any existing plant or plants:

1. Highest yield.
2. A tall plant.
3. A broad, thick plant, thus necessarily stooling abundantly.
4. With many culms and dense.
5. The plant must grow erect, showing no tendency to lodge.
6. The plant must have many and large leaves.
7. The leaves must extend well to the top of the plant.
8. The leaves must remain green until well into the harvesting period or until the heads ripen.
9. The plant must be in large degree resistant to rust.
10. The heads should be of medium size and should develop abundant and good seed.

All plants selected for practical purposes were examined with reference to these characters, and the best individuals, or types, found were selected for further trials. Illustrations of what are believed to be good types are shown in Plate II, Figs. 2, 3, and 4, and Plate III, Fig. 6.

Finally, the nutritive qualities and digestibility of the different types should be taken into consideration, but in the first stages of variety formation in a crop such as timothy these factors may well be neglected.

TESTING SELECTED PLANTS OF DIFFERENT TYPES

After a careful study of the variations and the different types presented, a large number of plants were selected as representing interesting and promising types. The important question then was, whether the various individuals showing valuable characters would reproduce those characters, or whether they were hybrids and unstable in nature. The selection and testing of such variations has formed the basis of the experimental work since 1907.

A study of the progenies grown from open-fertilized seed of plants selected in 1905 for special characters was found to show great variation and little indication of a transmission of the characters for which the plants were selected. Timothy is normally a cross-fertilized plant, and when plants are grown in a mixed field, where they are freely crossed with all sorts of pollen, this lack of transmission would be expected. In 1907 a few heads protected from cross-pollination by covering with paper bags gave a few good seeds, showing that at least some seed would set by self-fertilization. Since that time, each season a considerable number of the selected plants have been protected from cross-pollination by covering the entire plant with small cloth tents, or by covering certain heads with paper bags. In this way self-fertilized, or inbred, seed for testing has been obtained from a large number of select types.

In general, the most satisfactory method is to cover a group of about a dozen heads with a twelve-pound manila paper bag, just before they begin blooming. In order to insure the pollination of the heads inclosed in such bags, they should be shaken thoroughly early each morning during the blooming period to aid in the distribution of the pollen over the pistils.

The test of any particular chosen plant is conducted in the following manner:

1. The selected plant is propagated vegetatively by digging up and separating the bulbs that are formed in the stooling of the plant (Fig. 91). These are taken in early September and a row of sixteen to twenty-four plants grown. These plants, it will be understood, are only transplanted parts of the same individual. From such propagation the character of the individual can be judged better and a more nearly correct idea can be obtained of the yielding capacity of the plant as well as of other characters.

2. Inbred seed is grown carefully in sterilized soil and the seedlings transplanted in rows in field plats as above described, in order to test the transmission of the characters for which the plants were selected.

3. As soon as sufficient seed can be obtained, plats are sown broadcast in the usual way in order to test the yield under ordinary field conditions.

4. As soon as a variety is known or believed to be valuable, isolated plats are planted from inbred seed in order to obtain seed for planting larger areas that will finally give sufficient quantities of seed for distribution.

A large number of types have now been tested more or less thoroughly by these methods and very suggestive results have been obtained.

TESTING SELECTED TYPES AS CLONAL VARIETIES

In order to determine whether the different types selected in the field for certain characters represent inherent qualities or merely environmental difference, and also to study better the variations and types comparatively, they are tested by the first method indicated above.

In 1907 over two hundred different types were propagated in rows by taking the bulbs and growing them as clonal* varieties. The examination of these rows when they were two, three, and four years old showed wonderful differences in type and clearly demonstrated that the differences first observed in the individual seedlings were by no means accidental. Dwarf plants remained dwarf in such rows, and giants remained giants. Heavy yielders and light yielders maintained these qualities in considerable degree (Plate VI). In the

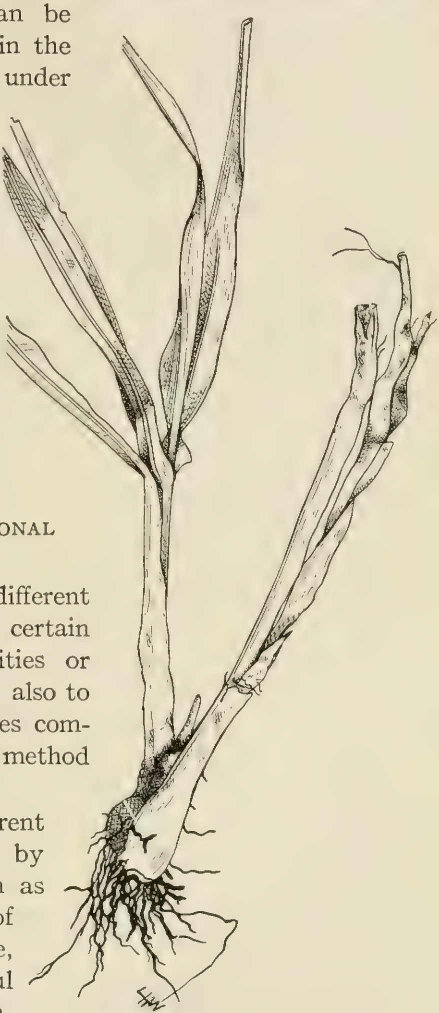

FIG. 91.—*Slip from timothy such as is used in clonal propagation*

following table, the records of the average yield per plant by clonal propagation in ten light-yielding and ten heavy-yielding rows will give an indication of the differences between the various types in this one important character. (See Table 1, column headed "Average yield per plant of mother by clonal propagation.")

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* A clon, or clonal variety, is one propagated vegetatively by cuttings, bulbs, or grafts, such as the varieties of strawberries, apples, and the like.

TABLE 1. Showing Transmission of Yield in Timothy by Clonal and Seed Propagation

Number of original plant	Plat no.	Average yield per plant of mother by clonal propagation (ounces)	Plat no.	Average yield per plant of progeny by self-fertilized seed propagation (ounces)
		Light-yielding plants		
12.07	1,797	1.005	3,216	2.121
9.03	1,713	1.830	3,109	3.364
104.30	1,794	1.982	3,213	4.071
191.19	1,785	2.283	3,142	3.143
811.02	1,728	2.542	3,166	1.925
128.19	1,799	2.462	3,217	0.966
211.31	1,792	2.806	3,211	1.905
212.36	1,653	2.811	3,143	4.140
8.04	3,011	2.941	1,959	3.714
107.30	3,033	3.158	1,960	1.182
		Heavy-yielding plants		
271.26	1,660	13.521	3,152	11.455
887.10	1,620	13.783	1,905	7.600
875.30	1,752	13.811	3,182	7.915
224.15	1,619	14.133	1,904	9.000
860.30	1,744	14.517	1,934	7.636
820.27	1,740	15.587	3,206	10.844
860.25	1,743	15.970	1,931	9.428
889.31	3,189	16.000	3,190	9.043
245.28	1,796	16.308	3,215	9.457
37.31	1,630	20.274	3,122	7.636

These tests were made with 16 plants from each individual, the different rows being placed 4 feet apart and the plants 3 feet apart in the rows. The plants in each row, coming from a single individual and propagated as clons, would naturally be expected to show great uniformity, but in no other method of testing are the characters of the individual brought out so distinctly. Among the 200 types there were no two rows that could not be separated one from another by some one or many distinctive characters. It would have been possible to construct a botanical key from which any one of the numerous types could have been determined, and this has been found to be an almost hopeless task with the races or varieties of many of our cultivated plants. The great range of variation is well illustrated by the character of yield. Taking the average yield for the second and third years of all the 16 plants of one kind, the lightest yielder averaged 1.005 ounces per plant and the heaviest 20.274 ounces per plant. Among the 200 plants, 5 gave for the two years an average yield per plant of one pound or over, while 39 gave average yields of less than one half pound per plant.

It should be clearly recognized that in many cases such characters as yield, height, number of culms, and the like, shown by the original plant, may not be exhibited in equal degree when the plant is propagated as a clonal variety and a number of plants are grown. The one original plant may have been grown in a particularly favorable or unfavorable place and the rows grown from it may thus be either poorer or better. New York soils are very variable and it is almost impossible to distribute manure uniformly; and there is thus every reason to expect that many of the size and yield characters exhibited by the original selections will be found to be due in some measure to the local environment in which the plant is grown. Some original plants, that were heavy yielders, when tested as clonal varieties gave only ordinary yields; while other original plants that were medium or even light yielders proved to be heavy yielders. The test in rows as clonal varieties is easily made and brings out the intrinsic characters of the individual as does no other method. When, in a test of this sort on fairly uniform soil, all the plants of a row exhibit the same characters and show differences between different rows or types, such as are illustrated in Plate VI, it may be taken as conclusive evidence that these differences are not due to environment. The test of individual selections in clonal rows is thought by the writer to be one of the most important steps in judging their comparative value.

On the other hand, a plant that gives very promising indications of value by this test may be of hybrid or mixed parentage and may not transmit its good characters by seed propagation. In attempting to produce good types, the experimenter would select the most promising sorts grown in clonal test plats and would then test the transmission of their qualities in seed propagation, using self-fertilized seed. This was the next step taken in the Cornell experiments. The various clonal plats were carefully studied and compared and the most promising types were selected for tests of their transmission by seed propagation. Many types of no apparent value, but showing interesting variations, were also selected for further testing and inbred seed was obtained.

THE EFFECT OF SELF-FERTILIZATION ON VIGOR

In timothy, as in other crops, it is necessary to inbreed or self-fertilize different individuals that are chosen as representatives of good types, in order to test the heritability of the characters for which a plant is selected and to secure seed true to the type for propagation. In almost all plants that are normally cross-fertilized, self-fertilization ordinarily results in considerable loss of vigor; and it is important to know what result, if any, timothy gives under such treatment, as a guide to one's judgment of the yield of progenies that have been so treated. In a number of cases in our experiments, self-fertilized seed has been grown immediately beside open-fertilized seed of the same individual. The open-fertilized seed used in such cases would thus have been cross-fertilized in the degree usually present in seed produced under ordinary field conditions. These yields compared with one another give a clear indication of the effect of inbreeding. In the following table are given the results of nine such tests with different types, each test including the average yields of about twenty-four plants for the second and third crop years:

TABLE 2. SHOWING COMPARATIVE EFFECT IN TIMOTHY OF OPEN-FERTILIZATION AND SELF-FERTILIZATION ON THE AVERAGE YIELD PER PLANT OF PROGENY

Plant no.	Yield of original plant 3-year average (ounces)	Yield per plant clonal propagation 2-year average (ounces)	Yield per plant open-fertilization 2-year average (ounces)	Yield per plant self-fertilization 2-year average (ounces)
3.21	11.680	8.409	5.696	4.739
12.35	8.693	5.000	3.043	3.231
15.21	9.440	5.000	5.533	3.721
63.01	7.147	9.292	4.958	4.889
245.22	12.800	8.625	6.267	4.769
271.26	9.600	13.521	10.667	11.455
278.40	5.013	10.513	10.000	7.244
291.19	10.080	9.792	8.250	3.758
Same number, another plat	......	......	8.250	3.384
Total weight......	74.453	70.152	62.664	47.190
Average weight...	9.307	8.769	6.963	5.243

In the above table the average yield of the original plant for three seasons is given in the second column. In the third column is given the average yield per plant for two seasons when each type is propagated in clonal rows. Each of these cases includes the average yield of 16 plants for the second and third crop seasons. In the fourth column is given the average yield per plant of the progeny of the same plants from open-fertilized seed, each case being the average yield per plant of about twenty-four plants for the second and third crop seasons of their growth. In the fifth column is given the average yield per plant of the progeny from self-fertilized seed, in each case being the average yield per plant of about twenty-four plants for the second and third crop seasons of their growth.

It will be seen from an examination of the table that in the majority of cases the original plant gave a larger average yield than did the clons of the same plant; the clons a larger average yield than the open-fertilized seed plants; and the open-fertilized seed plants a larger average yield than the self-fertilized seed plants. The average yield per plant for all types tested was: for the original plants, 9.307 ounces; for the clons, 8.769 ounces; for the open-fertilized seed, 6.963 ounces; and for the self-fertilized seed, 5.243 ounces. The open-fertilized plants thus gave an average yield for all cases of 1.72 ounces per plant more than the self-fertilized plants. In two instances the yield of the selfed-seed progeny exceeded that of the open-fertilized progeny, and doubtless such cases may be expected to occur occasionally. While the general loss in vigor from inbreeding is considerable, ordinarily not more than one inbreeding is necessary in order to obtain a fairly uniform type, and when open fertilization is allowed in the type later it is thought that the original vigor will be regained. This point, however, has not yet been thoroughly tested.

In making the first selections it was feared that the reduction in vigor from inbreeding might prove a serious obstacle in the prosecution of the experiments, and the scheme was tried of attempting to choose unrelated seedlings exhibiting the same characters and general type, which could be crossed together in producing a fixed type. In such tests the two plants of the same type were planted close together in short clonal rows so that the entire plat could be covered by a tent during the blooming period, thus allowing the plants to interbreed freely. All such trials were failures, as in every case the two types selected proved to be of different germinal constitution and the progeny showed no general similarity of type.

TESTING THE TRANSMISSION OF TYPE IN SELECTIONS WHEN GROWN FROM SEED

(See Plates VII and VIII)

In 1908 and 1909 test rows of plants from inbred seed of a considerable number of different types were planted, and in many cases by the side of these were grown, for comparison, similar rows from open-fertilized seed and from clons of the same original plant. Here, as in all other cases, the seeds for planting were germinated in sterilized soil and later transplanted into the field. In the majority of cases in these plats, twenty-four seedlings from each type were grown.

These plants had reached sufficient age in 1910 and 1911 to enable a safe judgment to be made as to the general transmission of the characters for which they were selected. The writer is now able to state definitely that a very large number of the variations selected have transmitted their characters in marked degree. Indeed, many of the types appear to be fully as uniform as the varieties of wheat or corn that we have in cultivation, and are as nearly fixed in type as are ordinary commercial varieties. As would be expected, however, many of the types selected proved to be of hybrid nature and such types broke up and frequently gave very numerous types. In some cases the variations among the seedlings from one original plant were so numerous that no similarity to the original plant could be discerned.

The factor in which most interest centers is the transmission of yield and of those characters on which yield depends. While some of the plants that were heavy yielders in the clonal tests failed to transmit this quality to any marked degree, in general the light yielders in the clonal tests were light yielders by seed propagation and the heavy yielders in the clonal tests were heavy yielders by seed propagation. In Table 1 (page 356) are given the average yields from second and third year crops of ten of the lightest- and ten of the heaviest-yielding clonal types, and similar two-year average yields of the seedlings grown from them. It will be seen from this table that light-yielding plants gave light-yielding progenies, heavy-yielding plants gave heavy-yielding progenies. There is of course considerable variation, and occasionally a plant tested as a light yielder in the clonal plats would give a good yield in its seedlings. By an examination of all the plants that were tested for their yields as clons and by seed propagation, it is clear that, in general, as the yield of the clons increased the yield of the seedlings increased.

This is illustrated graphically in Fig. 92. In this figure, the ascending, heavy, solid line represents the yields of 100 individuals tested as clonal varieties, and the broken line the yields of the seedlings from inbred seed of the same individuals. The yield is indicated by the height from the basal line, each horizontal line representing one ounce. The plants were arranged in order of sequence of average yield of clonal plants for two years, and each dot represents the average yield of five such plants. The first dot at the beginning of the solid line on the left represents the average yield of the five lowest-yielding original plants as shown by their clonal tests, and the next dot the average yield of the next five in order of yield, and so on throughout the series. The circles on the broken line represent the average yield of the seedlings from the same five individuals represented by the corresponding dots on the solid line.

From a study of this graphical illustration of the comparative average yields, it will be seen clearly that as the yield of the clons of an individual increases, there is also, in general, an increase in the average yield of the inbred progeny of these individuals. It is also interesting to note that the average yield of the inbred progeny does not increase nearly so rapidly as does the yield of the clonal plants; in other words, there is considerable regression in the yield of the progeny. This is also shown in the comparative transmission of yields of ten light- and ten heavy-yielding plants, as appears in Table 1. Here it will be seen that, in general, the ten lightest-yielding original plants have given rather heavier-yielding progenies; the regression being positive and toward the mean yield of the species, which is much greater than the yields of these ten plants, selected as extreme illustrations of light yielders. In the ten heavy-yielding plants, selected as extremes of this character, the progeny yields are much below the yields of the original plants, there being a marked negative regression toward the mean yield of the species.

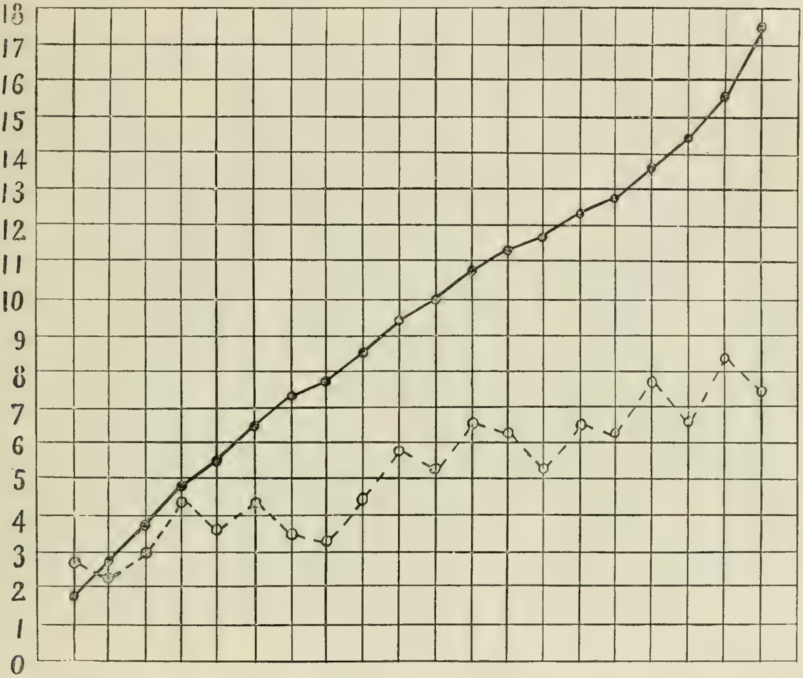

FIG. 92.—*Diagram showing the comparative yields of 100 different types grown as clonal varieties, with the same types grown from inbred seed. Black line—clonal yields; broken line—yields by seed propagation*

There are two factors acting here that make this regression appear more marked than it really is. In the first place, plants propagated by bulbs, as clons, start more rapidly than do seedlings and produce larger plants as a result; so that the yields in the second and third years, which are taken in all cases in these experiments in comparing plants, are rather larger for clonal plants than for seedlings of the same age (Table 1). In the second place, in this diagram of comparative yields the seed propagation was all from self-fertilized seed and there is a considerable loss of vigor due to this cause. (See the preceding section, p. 358, Table 2.) If the proper correction for these two factors could be made, it is probable that the increasing yield in the original plant would be followed, on the average, by about an equal increase in the yield of the progeny.

It is not necessary for our purpose in this bulletin to discuss the transmission of all characters in detail. It is necessary only to state that such characters as height and diameter of plant, number of culms, and other characters influencing yield, were transmitted in very much the same degree as was yield. In many instances such characters as long leaves, broad leaves, large heads, small heads, branched heads, and the like, were exhibited by all the seedlings, showing that the parent plants were pure with reference to these characters.

In many cases the careful examination of the seedlings grown from different types showed that all the main characteristics had been inherited and the types could be considered as practically pure races. As an illustration, one of the original plants (Plate II, Fig. 4) selected as valuable formed very large and dense, strictly erect plants, which were leafy well to the top and very late in season. The whole appearance of this plant was very characteristic and every plant in the clonal test row showed the same characteristics and was uniformly good. Inbred seed of this plant produced progeny that were exceedingly uniform in all their characters and were so nearly like the original plant that they might easily have been mistaken for a clonal row. This uniformity of type transmission can be seen by an examination of Plate VII, Fig. 2, right-hand row. We may safely conclude that we have here a type which reproduces its characters true, and which, if valuable, could be sent out immediately as a distinct new race or variety.

A large number of plants differing widely in their characters were found to reproduce similarly true to type, and thus these may be considered as so many distinct new races or varieties. The further problem in connection with such races is to determine whether the high-yielding, good-quality sorts selected from the above tests will continue to show the same characters when they are sown broadcast and grown as is timothy ordinarily. The experiments outlined have shown that timothy, as ordinarily grown, is composed of very many different types; and that by the isolation of the various types and by inbreeding, many of them are found to transmit their characters and are thus to be considered as distinct races.

TESTS OF NEW VARIETIES OF TIMOTHY

(See Plate IX)

We have described above the process by which a considerable number of new timothy varieties have been produced. When grown in rows, one plant in a place, some of these varieties gave very large yields in comparison with other varieties and would seem to be of value (Fig. 93). The practical grower, however, will immediately inquire whether these qualities or differences in yield are shown when the various sorts are grown in the ordinary way by broadcast sowing; for of what value are they unless their good qualities are maintained under ordinary methods of culture?

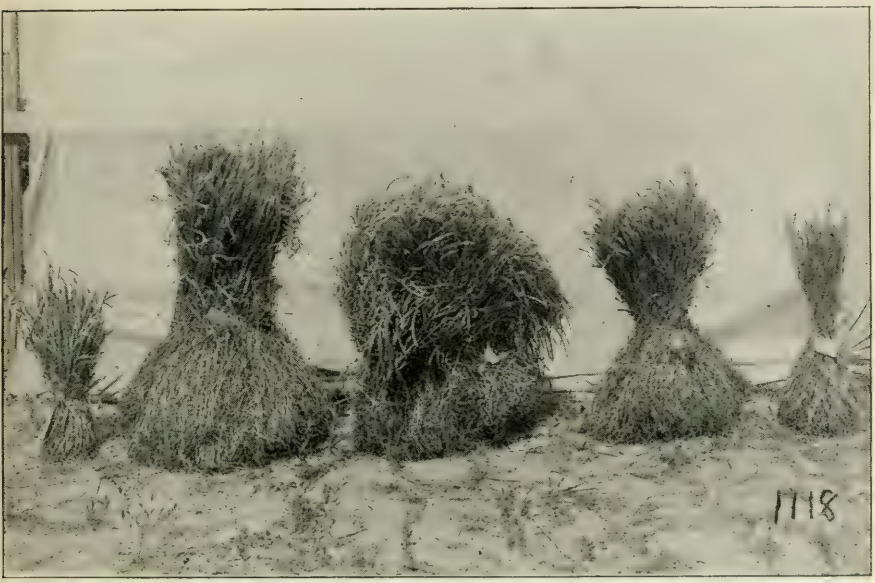

FIG. 93.—*Bundles of different types of timothy showing the comparative cuts from different rows of selfed pure types*

Seventeen of the new types were selected for trial and plats were sown with open-fertilized seed. The seed was taken from rows of these varieties propagated from bulbs and, while not isolated, they were very much less subject to crossing than when one plant of a new type stands alone in a mixed field. The later experience with the plats grown from this seed demonstrated that there was little crossing, as the plats of the different sorts clearly exhibited their various characters, such as lateness and earliness, color and form of head, and the like. The plats were 1 rod wide and 4 rods long, thus containing one fortieth of an acre, excepting in the case of four varieties, of which a shortage of seed necessitated using smaller ($\frac{1}{2}$ rod wide) plats. These plats were sown about the middle of September, 1909, the same comparative rate of seeding, 16 pounds per acre, being used in each case. Every fourth plat was used as a check and planted with seed of ordinary timothy. The seed for the check plats was purchased from a local seedsman and was the best timothy seed that he supplied to his trade. As uniform a piece of soil as could be obtained was selected for these tests and was lightly manured before the seeding at the rate of 10 tons of stable manure per acre.

From a study of Table 3 (page 365) it will be seen that in 1910 three of the new sorts, 1,841, 1,849, and 1,853, produced less than the yields of their estimated checks, but that in the other cases the yields were much in advance of the checks. In this year all the 17 new sorts gave an average yield of 7,451 pounds per acre, while all the check plats gave an average yield of 6,600 pounds per acre. The new varieties, even including the three low yielders, gave an average increase of 851 pounds per acre.

In 1911, which was in general a less favorable season for timothy than was 1910, all the new sorts showed substantial gains over the checks. In this year the average yield of all the 17 new sorts was 7,153 pounds per acre, while the check plats gave an average yield of only 4,091 pounds per acre. The new varieties in this year thus gave an average increase per acre of 3,062 pounds, or over one and one half tons per acre. The reason for the decrease in the check plats in the second season is clear to one who has followed this work. Ordinary timothy rusts badly and, owing to lack of vigor, is comparatively short-lived. A large part of the decrease is due to these causes, but it is also due in some measure to the poorer season. On the other hand, the new varieties were selected for vigor, rust resistance, and ability to stool, and they would naturally increase in size for three or four years and would gradually cover the ground more thickly. Clearly, these varieties were cut down by the poor season, or they would have given a better yield the second year than the first. Throughout this experiment, which was made as uniform as possible for every plat, the new varieties have clearly shown their superiority over the ordinary timothy in greater height and in thicker development on the ground. (See Plate IX and Fig. 94.)

Furthermore, it is important to note that the hay produced by the new varieties was apparently of superior quality to that from the check plats. Several hay dealers who were expert judges of the quality of hay visited

TABLE 3. SHOWING YIELDS PER ACRE OF FIELD-DRIED HAY IN 1910 AND 1911 OF 17 NEW VARIETIES OF TIMOTHY IN COMPARISON WITH ORDINARY TIMOTHY*

		1910 yield in pounds			1911 yield in pounds		
Plat no.	Parent no.	Yield per acre	Check yield per acre estimated	Gain in yield per acre	Yield per acre	Check yield per acre estimated	Gain in yield per acre
C 1,831	Check	**5,280**	5,280		**5,400**	5,400	
1,832	1,606	6,720	5,410	1,310	6,880	5,050	1,830
1,833	1,611	7,000	5,540	1,460	7,760	4,700	3,060
1,834	1,620	6,680	5,670	1,010	7,040	4,350	2,690
C 1,835	Check	**5,800**	5,800		**4,000**	4,000	
1,836	1,627	7,680	6,000	1,680	8,320	3,990	4,330
1,837	1,629	8,320	6,200	2,120	8,080	3,980	4,100
1,838	1,630	7,600	6,400	1,200	7,320	3,970	3,350
C 1,839	Check	**6,600**	6,600		**3,960**	3,960	
1,840	1,653	7,440	6,790	650	7,680	4,050	3,630
1,841	1,668	6,040	6,980	—940	7,160	4,140	3,020
1,842	1,671	7,640	7,170	470	7,240	4,230	3,010
C 1,843	Check	**7,360**	7,360		**4,320**	4,320	
1,844	1,676	8,200	7,260	940	8,280	4,140	4,140
1,845	1,684	7,280	7,160	120	6,920	3,960	2,960
1,846	1,687	7,600	7,060	540	6,080	3,780	2,300
C 1,847	Check	**6,960**	6,960		**3,600**	3,600	
1,848	1,715	8,000	7,120	880	8,040	3,560	4,480
1,849	1,722	7,240	7,280	—40	6,280	3,520	2,760
1,850	1,743	7,520	7,440	80	5,880	3,480	2,400
C 1,851	Check	**7,600**	7,600		**3,440**	3,440	
1,852	1,745	Road put through this plat				3,560	
1,853	1,748	6,520	7,440	—920	5,280	3,680	1,600
1,854	1,777	9,200	7,280	1,920	7,360	3,800	3,560
C 1,855	Check	Out			**3,920**	3,920	
Average yield, 17 new sorts.		7,451 lbs. per acre			7,153 lbs. per acre		
Average yield, checks.		6,600 lbs. per acre			4,091 lbs. per acre		
Actual average increase.		851 lbs. per acre			3,062 lbs. per acre		

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* In the above table the column headed "Check yield per acre estimated" may need explanation. The comparison of two plats grown side by side may not be fair, as the land changes somewhat, even in one rod. We desire to get as nearly as possible an estimated check yield for each plat of what the check seed would have given if sown in that plat. Taking a specific illustration, in 1910 Check Plat 1,831 yielded 5,280 pounds per acre, and the next Check Plat, 1,835, gave 5,800 pounds per acre. Evidently for this season the land is getting better as we proceed toward the second Check Plat, 1,835. The difference between the two checks is 520 pounds. In every four plats there is one check and one fourth of 520 pounds is 130 pounds. Now if we add 130 to the yield of Plat 1,831 we get the estimated check yield for Plat 1,832, which is 5,410 pounds. Adding 130 pounds to this gives us 5,540, the estimated check for Plat 1,833. This will probably make the method clear. The correction number between each two checks will obviously be a different number in most cases.

the plats during the season. They stated without reservation that the quality of hay produced by the new sorts, owing to the retention of a fresh green quality and leafiness, would be superior to that on the check plats of ordinary timothy. This apparent superior quality is due in the main to the greater rust-resistant character of the new sorts and to the fact that the majority of them were selected as " green leaf " types, that is, possessing the ability to retain their leaves and stems green until the heads have become fully mature. This character is doubtless due in large measure to the inherent vigor of the types and to their resistance to rust.

At the time of harvesting the broadcast plats, the difference in greenness between the selected types and the ordinary timothy on the check plats was very noticeable. A much larger proportion of the basal and lower leaves was dried up and dead on the check plats, which was clearly not due to greater earliness of the ordinary timothy.

The various new types in this test differed considerably in season of maturing, some being early, others late, and others mid-season. While there was much variation as to time of maturing among the plants on any plat and, in general, the differences were clearly shown, the plats of the selections ripened much more uniformly than did the ordinary timothy on the check plats. In view of the great importance of cutting timothy at a certain stage in its development, which will be discussed in an appendix to this paper, it would seem to be important to have the crop matured as uniformly as possible in order to secure the best yield and the best quality of hay. Up to the present time no attention has been given to this very important factor in growing timothy hay, as we have had no different timothy varieties to compare.

The comparative yields as given for two years in Table 3 may profitably be more carefully analyzed. It is not to be expected that all the types selected as promising will prove equally good. Indeed, we should rather expect that some will fall down and prove worthless. The most surprising thing in this experiment is the uniform superiority of all the new types tested. It is interesting, however, to note the variation in the yield of the new types. In the column showing gain in yield for 1910, it will be noticed that three varieties gave an increase in yield of over 1,500 pounds per acre, and these three varieties were among the heaviest yielders in 1911. While the average gain in yield per acre in 1911 was only slightly more than 1½ tons per acre, being 3,062 pounds, four varieties gave over 2 tons per acre. In this year the six best-yielding sorts in comparison with their corresponding check plats gave an average increase of 4,040 pounds per acre. Naturally, for new varieties or races for general propagation we should select the very highest yielders among our new types, and in this experiment we should select possibly the six or eight highest yielders for further trials on different soils.

These trials in broadcast plats, together with the tests of the same types in clonal rows and in rows from self-fertilized seed, give us a good basis for a preliminary decision as to the best sorts among those under trial. If a type has stood high in the yield of a good quality of hay in all these three methods of testing, it is believed that it may with reasonable safety be judged as a good race, at least for local use on the same type of soil as that on which the selections have been made. On this basis of judgment the half dozen best races, which in our experiments have been found

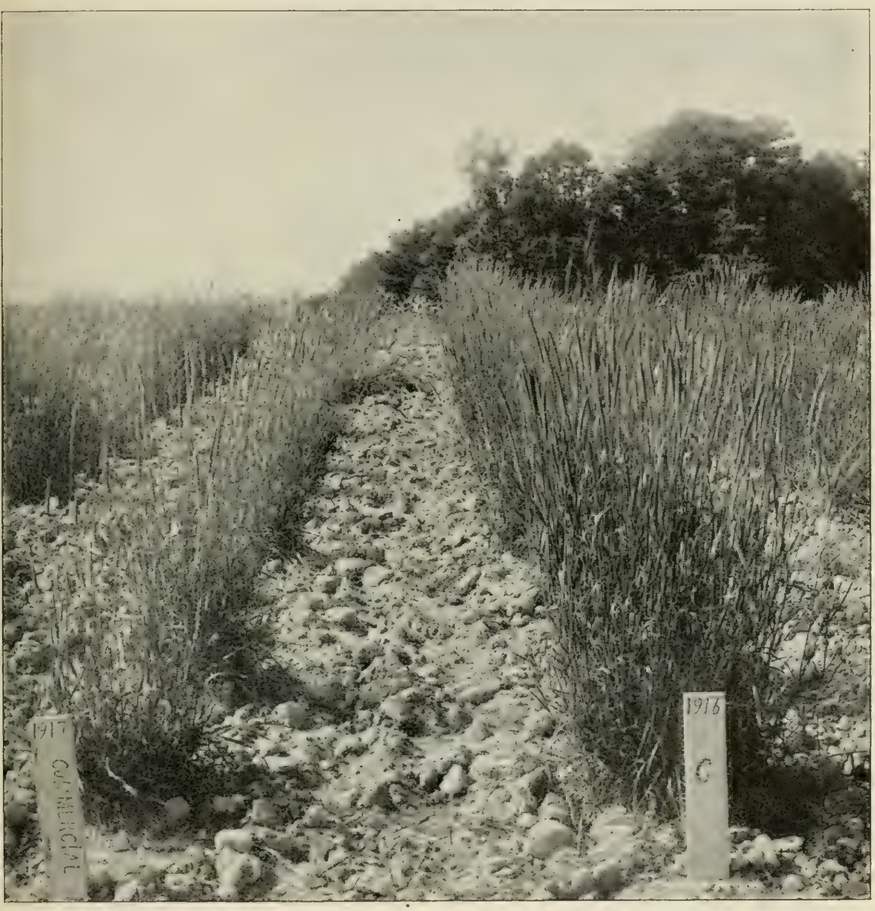

FIG. 94.—*Row on right No 1916, grown from selfed seed of a select type; row on left, No. 1917, grown from good commercial seed*

to breed true to type and which have given superior yields in clonal rows, inbred seed rows, and broadcast plats, have been chosen as worthy of presentation to the public as superior new varieties. These will be propagated as rapidly as possible and will be distributed to farmers of the State as soon as sufficient seed can be produced.

It must be recognized that these varieties have not been tested on various soils and it is possible, and even probable, that some of them may fail to give good results under other conditions. Trials of a number of types are being made in different parts of the State and these will probably give next year some hints of what can be expected; but the final value of a new race of any plant can be determined only by its success in extensive commercial cultivation over wide areas. The breeder's introduction of any variety or race, though based on the most careful experimental trials, must nevertheless be an experiment and only after a number of years of general cultivation can the true value of the variety be determined.

METHOD OF ISOLATING A PURE TYPE AND MULTIPLYING THE SEED

In the Cornell experiments, two methods of isolating a pure type have been pursued. In the first method, when the test of a type in rows grown from inbred seed shows that the type has reproduced its important characters and can be considered as a fixed variety, good typical plants in the trial rows are selected and their heads bagged in order to procure self-fertilized seed. Following this, the selfed seed is grown in sterilized soil and the little plants are transplanted at the proper time into small plats, which are placed so that they will be at least one hundred feet, or preferably a greater distance, from one another and from any other timothy. Rye, or some other tall crop that will tower above them when they are in bloom, is then grown around these plats (Fig. 95). In such plats the individual plants have been placed 18 inches apart each way, which arrangement allows of some cultivation at first and gives sufficient distance for each plant to develop separately so that the plat can be examined carefully before flowering and all inferior or off-type plants pulled out.

The second method used is similar to the first, excepting that clons are used instead of inbred seed. By this method, when a type grown in test rows from inbred seed is seen to come true to seed and represents practically a fixed race, good plants, typical of the type, are selected from the test rows and dug up at the proper time and the bulbs used in planting an isolated plat in a rye field. Seed from these small isolated plats will be produced in sufficient quantity to sow larger broadcast plats from which still larger quantities of seed will be obtained.

The isolation of the fields from which seed is to be taken must necessarily form an important factor in the seed production of timothy varieties. Timothy is naturally cross-pollinated to a considerable extent, the pollen being carried by the wind; nevertheless, observations during the experiments have shown that a considerable part of the seed naturally produced is evidently self-fertilized. While no distance of isolation that is practicable under ordinary conditions would entirely prevent the possibility of crossing, it is believed that one to two hundred feet, if accompanied by some barrier that may be formed by a surrounding taller crop, such as rye, will give sufficient isolation in seed production for practical purposes.

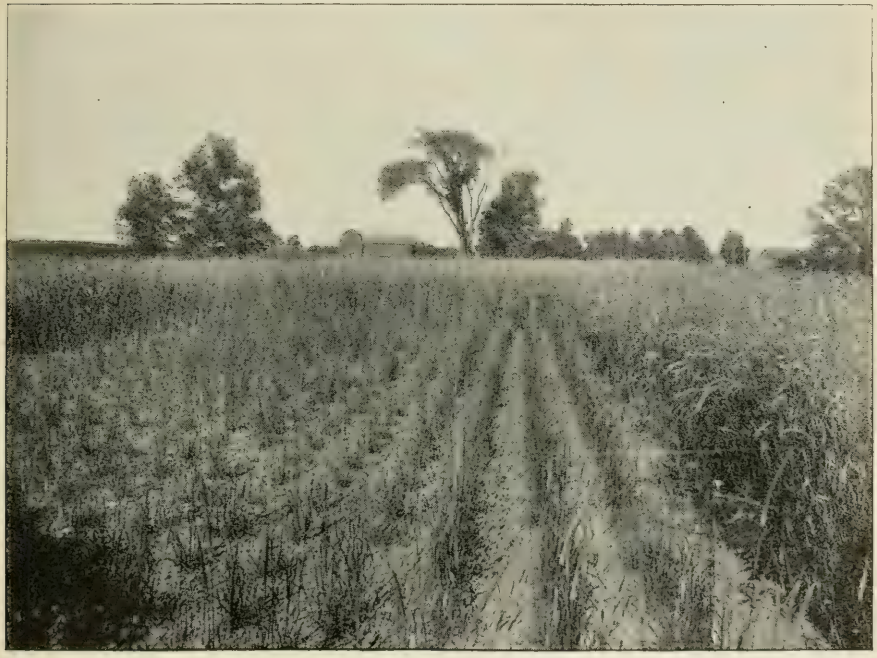

FIG. 95.—*An isolated plat of a pure strain, planted in a rye field to protect it from pollination with other types*

PROBABLE VALUE OF THE NEW RACES PRODUCED

It may seem surprising to those unfamiliar with plant-breeding principles that such striking results as are shown in Table 3 can be obtained in so short a time. It is truly rather remarkable, but is in no sense a greater increase than would be expected under the conditions. When it is remembered that timothy is one of the crops most generally grown in the civilized countries of the world and that it has been cultivated for about two centuries under very widely differing conditions of soil and of climate, we can see that every opportunity possible has been furnished for the stimulation of variations. We know now that a variation once produced is rarely lost in nature, but usually is added to the total character variations of the species. Through many years and over millions and millions of acres, among countless billions of plants, these variations have been accumulating, with no attempt having been made to isolate them and use the best for the foundation of improved races for cultivation. Is it any wonder, then, with this great accumulation of material, that by selecting the best variations we get races that yield nearly double the product obtained from the mixture of all sorts of types? Suppose, for comparison, apples had not been bred for the last two centuries and we had a forty-acre orchard planted with all sorts of variations taken at random, including the worthless wild types and all other sorts such as would have been produced in this period of cultivation without selection. What would be the comparison of value between the crop of such an orchard and the crop from a similar forty-acre orchard planted with Northern Spy or with any one among several hundred of our good modern varieties? The crop from the unselected varieties would in large measure be wholly unsalable in our modern markets. Probably not more than one sixth of the crop could be sold for any purpose and it is doubtful whether even one tree on the forty acres would produce a crop that could be compared with the fruit of our modern sorts. If we compare the results obtained in timothy, therefore, with a similar illustration in apples, we can readily see that the timothy results as obtained in the experiments described above are no greater than, if as great as, we might expect. Indeed, the writer feels that only a beginning has been made up to the present time.

Hay is one of the largest agricultural crops of the United States, outranking all other crops except corn in total value of production. In 1910, according to the statements issued by the United States Department of Agriculture, there were grown in the United States 45,691,000 acres of hay, which yielded a crop having a farm valuation of $747,769,000. No statistics are available from which we can determine what proportion of this hay was timothy, but the writer believes we may safely conclude that at least one third of the entire hay crop of the country is timothy. If this is true, the timothy crop of the United States in 1910 had a valuation of over $249,000,000. In the two years during which tests have been made, the 17 new sorts gave an average increased yield of slightly over 36 3/5 per cent above ordinary timothy. A 36 3/5 per cent increase in the valuation of the timothy crop as above estimated would give over $90,000,000 as the estimated annual gain in value that would be obtained if equally good new sorts could be used throughout the country.

In the State of New York timothy is particularly important, as hay is by far the greatest agricultural crop grown. According to statistics given by the United States Department of Agriculture for 1910, New York grew in that year 4,811,000 acres of hay, yielding 6,351,000 tons, which was valued at $87,009,000. If half of the New York hay crop was timothy (and this is thought to be a fair estimate) New York grew in 1910 a timothy crop that had a valuation of $43,504,500. If now we could extend the cultivation of the best of these new races all over the State of New York and they would give an increase of 36 3/5 per cent in yield, which was obtained as an average for the 17 new races for two years, they would add over $15,922,000 annually to the valuation of the crop in New York.

It must be remembered that such figures are merely estimates and mean but very little, apart from giving us quickly a comprehension of what such experiments under ideal conditions might mean to the country. The writer would state very emphatically, however, that he believes it would be entirely possible to increase the yield of the crop to this extent if it were possible to have every field of timothy in the State sown with that one of these new varieties best adapted to local conditions. In New York, which is the largest hay-producing State in the Union and the one in which these varieties have been developed, their introduction into cultivation should result in a marked increase in the average yield.

WHEN CAN SEED OF THE NEW SORTS BE OBTAINED?

For the next one or two years, it is probable that every seed of the new varieties available will be grown to increase the supply. Every effort will be made to get these varieties into the hands of growers at the earliest possible date. While timothy increases very rapidly, a considerable period must necessarily intervene before the seed will be available in large quantities. The writer would request that growers do not ask for seed at the present time, as it cannot now be supplied.

A METHOD OF IMPROVING TIMOTHY, RECOMMENDED FOR THE USE OF FARMERS

The breeding of corn and potatoes has become common practice with farmers in certain parts of the country, and, while the methods employed are usually simple, they are known to produce excellent results and to justify their more general use. The simplest methods for many crops, which we are able with our present knowledge to recommend, are too complex to justify their general use by farmers. Indeed, the simple methods of breeding that are generally recommended for corn are little more than an extended method of selecting good seed; they go one step further, however, in testing the yielding capacity of the individual through a comparison of its progeny and selecting the seed from the progeny of the best yielders. From the length of time and the cost of the timothy experiments, the writer has until recently thought it impracticable for farmers themselves to undertake any work in the improvement of the seed of their timothy. In carefully considering the results of the experiments, however, he has come to the conviction that farmers can improve their timothy by a method as simple and as easy of execution as the methods used by many farmers in corn breeding, and that they can be far surer of obtaining results of value than with corn.

The following simple method of improving timothy seed is thus recommended for the use of farmers who desire to improve their timothy crop:

1. *Manner of procuring seed for starting a selection.*— When timothy is ripening, go over a field carefully and choose a number of good, ripe seed heads from tall, robust culms, which appear to come from good plants. Also, look for exceptionally good plants along the roadsides and fences, and wherever good plants are found preserve good heads for seed. In this way choose good seed heads from at least ten or twenty good plants. Thresh the seeds from these heads, keeping separate the seeds from each plant, and sow them immediately. No time should be lost.

2. *Planting the seeds.*— As soon as the seed from the selected heads has been threshed, take small boxes, about 2 feet long by 1 1/2 feet wide and 4 inches deep, and fill them with good soil from some location where there has been no timothy and thus where there is little likelihood of timothy seed being in the soil. Pack the soil down in the box slightly and smooth off the top, removing all lumps. Now plant the seed from the different heads in short rows in the boxes, placing the rows about 2 to 2 1/2 inches apart. Be careful to keep the seeds from each head or plant separate from one another and plainly labeled. In planting the seed, open shallow furrows in the soil and sow the seed in the furrows by hand, arranging so that the seed will be covered about one fourth of an inch deep when the dirt is pushed back in the furrows. Sow the seed rather thickly in the rows, but expect to thin out later so that the plants will stand about 1 inch apart in the rows. Sow enough seed so that when properly thinned there will remain about 50 plants from each of the selected heads.

After the seed is sown (and this should be done as soon as the heads are gathered), water the seed boxes carefully with a fine spray, in order to prevent washing the seed out. A good way is to cover the box with an open-mesh cloth, such as cheesecloth, and sprinkle the water on this cloth until the soil is thoroughly wet. Then place the seed boxes in the shade in a moist place, as on the north side of the house. It is a good practice to keep the boxes covered with paper until the young plants begin to appear, and it is important to keep them well watered at all times. When the young plants are well up, thin them to about 1 inch apart in the rows, leaving the strongest plants.

The plants can be kept in the boxes until about the 15th of September, when they should be planted in the field. About ten days or two weeks before transplanting the plants to the field, they should be gradually exposed to the full sunlight and dried out somewhat in order to harden them up. (Read page 344 of this bulletin.)

3. Transplanting to the field.— Choose a place in the field where the plants may remain for at least two years without being disturbed. A good piece of land should be chosen, but not necessarily the best; one should take the ordinary soil of the farm, such as would be used for timothy. Set the plants 2 feet apart in rows that are 4 feet apart. Plant all the seedlings from one head in a row by themselves, so that there is a row for each original selected head. If ten heads were originally selected and fifty plants are grown from each head, there should be ten rows 100 feet long, thus occupying a piece of land 40 by 100 feet.

In transplanting the seedlings from the boxes, a time must be chosen shortly after a good rain, when the soil is well moistened. The plants should be set out at some period between the 10th and the 20th of September, if possible, so that they may become well rooted before winter comes on. It may be necessary to hoe them before winter, but this is not likely to be the case if the land is well prepared before the planting. This plat may be designated as the " seedling test plat."

4. Cultivating the seedlings.— In the early spring the seedlings should be cultivated and hoed, and the cultivation and hoeing must be done thereafter at sufficiently frequent intervals to keep the ground free from weeds and in good condition, as in the case of any other crop, such as corn. These plants will produce a few culms each the following summer, which should be cut early in order that the strength may go into the general growth. Do not attempt to select the best plants the first season. A safe judgment cannot be rendered until the second season.

5. Selecting the best plants.— When the plants reach the stage for cutting in the second summer, that is, when they are in full bloom, the final selection of the best individuals can be made. Examine each row critically in order to determine which head or heads have given the best progeny as a whole. If any one or two rows are markedly superior to the others, select several of the best plants in each of these good rows, marking the selected plants by stakes driven down by their sides. (In order to determine the character of a good timothy plant, read the section of this bulletin on "Types of Timothy Varieties Desired," [page 353] and examine especially Plate II, Figs. 2, 3, and 4, and Plate III, Fig. 6.) Also select the one best plant in each of the other rows and mark these plants by stakes as suggested above. Now cut the crop developed on all the plants, in order to let the fall growth start early.

6. *Testing the selected plants as clonal varieties.*— In order to make a further test of the fourteen or fifteen plants that will have been selected in accordance with the preceding paragraphs, between the 5th and the 20th of September choose another uniform plat of fairly good soil and prepare for planting an area slightly over 60 feet square. This plat should be located at some distance from any other timothy, preferably at least 200 to 300 feet. When a good season for planting comes, following a rain, dig up each selected plant in turn and separate the bulbs or slips (Fig. 91, page 355), and use these in planting a row from each of the plants selected and marked. As before, place the rows 4 feet apart and the plants 2 feet apart in the rows. Transplant about thirty slips from each of the selected plants, so that there will be a single row about sixty feet long from each. The transplanting is very easily and quickly done. This plat may be designated as the "clonal test plat." If one desires to see what differences exist in timothy, a few low-yielding plants should be chosen, also, and planted by slips in the clonal test plat.

As soon as this clonal test plat is planted from the selected plants, the seedling test plat may be plowed up and used for other purposes.

7. *Cultivation of clonal test plat.*— The clonal test plat should be cultivated and hoed sufficiently to keep the weeds down and to allow the full development of the plants.

8. *Selecting the best clonal rows.*— As in the seedling test plat, the plants in the clonal test plat cannot be satisfactorily judged until the second season after planting, and all that is required previous to this time is the cultivation and harvesting of the plants the first season before the seed falls. When the plants are well headed the second season and are about to begin blooming, the final examination can be made. Now go over each row carefully and examine it with reference to yield and desirability of type, and select the superior row or rows. It will be best to retain at least two or three of the best rows, or more if there is but little difference in them. Good early-maturing and good late-maturing rows should be retained if both are present in the test plat.

When this selection of the best rows has been made, cut the crop on the discarded rows immediately so that the pollen from these discarded rows will not contaminate by cross-fertilization the seed developing on the selected rows. At any convenient period these discarded rows may be dug up or plowed out, as they will be needed no longer.

9. Propagating from the select rows.— The rows selected from the clonal test plat should represent almost certainly superior types and all the seed on these rows should be allowed to ripen, when each row should be cut and threshed separately and seed retained to plant multiplication plats, as described in the next paragraph. By a little cultivation the selected rows in the clonal test plat may be retained for at least five or six years, and probably longer, as a source of supply of seed of a superior kind. In order to utilize the land around them where the discarded rows were cut out, some vegetables could be planted each year; and manure applied for the vegetables would benefit the timothy rows. As the rows of select types begin to run out or become impure by volunteer timothy plants around them or by other grasses growing in the clumps, other and more extended clonal rows could be planted from them.

10. The multiplication plat.— The seed taken from the select rows of the clonal test plat should be sown in the early fall, sometime before the 15th of September, in broadcast plats as large as the amount of seed obtained will permit. The land on which the seed is to be sown should be lightly manured, plowed, very thoroughly harrowed, and pulverized. Good preparation for timothy pays as well as does good preparation for alfalfa. Sow these plats as timothy is ordinarily sown, at the rate of about sixteen pounds of seed per acre. There should be enough seed from each row to plant about one eighth of an acre. If the seed from each select clonal row is sown in separate plats adjoining one another, the superiority of one type over the others for field conditions may be judged and finally all but the best types eliminated. The seed from these broadcast multiplication plats can be utilized the next year to plant a fairly large field, which in turn, if desired, may be harvested for seed to plant still larger areas. The various multiplication plats may be grown for several years before they become too weedy to utilize, and the time may be extended, if desired, by surface dressing with manure and by pulling such weeds as come up in the plats.

11. Continuation of the selection.— If the farmer has in mind the continuous improvement of his seed with the view of ultimately selling seed regularly as improved seed (which policy is certainly to be commended), a number of seedlings should be grown in flats or boxes, as described in paragraph 2, from seeds of each of the selected rows in the clonal test plat. It will be remembered that each of these rows represents a single selected individual that has been propagated by slips, and by growing seed from these rows we are merely growing so many seedlings from the original selected plants. The number of seedlings to be grown from each row should depend on the time that the grower has to give to the work and on the emphasis that he desires to place on his breeding. Here, as in all other breeding work, the larger the number of individuals used, the better. The writer would advise that not less than 300 to 500 plants be grown from seed of each of the select rows. These seedlings should be cared for as in the case of the first plants grown, and in early September they should be planted in a seedling test plat, following the methods outlined in paragraph 3.

When these plants reach the second crop year they should be examined and a few of the best individuals selected as in the case above, paragraph 5. These selected individuals should be dug up at the proper time and clonal test plats planted, as described in paragraph 6. From these clonal test plats the best rows should be selected, as in paragraph 8, and broadcast field test plats grown, and the seed multiplied as in the case of the first selections (paragraphs 9 and 10) until sufficient seed for growing large areas has been obtained.

A careful study of the method of breeding timothy outlined above, considering the length of life of the plant, will reveal that the extra trouble and work required are much less and really simpler than are required by the methods of corn selection advocated for farmers, which are being extensively used in some States. This method is the direct outgrowth of the experiments that have been conducted at Cornell, and has thus been thoroughly tested in practically every feature.

In making such selections as are outlined, it would be well, so far as possible, always to do what one can to get at least one early- and one late-maturing type in order that the harvest may be better controlled.

APPENDIX

WHEN SHOULD TIMOTHY HAY BE CUT?

A considerable part of the value of the hay crop depends on the season at which it is cut. In the Eastern and New England States, the farmers usually aim to cut their hay soon after the plants are in bloom, but a considerable part of the crop is cut at a much later period; in the Central or Corn Belt States, the cutting is usually done at a later period. At present there is little exact knowledge available from which a rational practice can be established, the farmers' practice in general being based on no very definite information. Lacking definite knowledge of the damage from late cutting, the grower, if other work is pressing, is likely to neglect his haying, thinking that it makes little difference if the crop is not harvested until rather late. We need to know definitely at what period of cutting the largest yield per acre of dried hay can be obtained, which will at the same time give us the largest yield per acre of nutrients of the highest digestible ratio.

There has recently appeared a paper by President H. J. Waters, of the Kansas Agricultural College, entitled "The Influence of Maturity Upon the Value of Timothy Hay,"* which is of great value to hay growers and the results should be generally known. The following is a review of President Waters' experiments and results:

Cuttings of hay were taken at five periods of development:

First cutting: When the plants were just in full head, on the average about June 12.

Second cutting: When the plants were in full bloom (Fig. 96), about June 20.

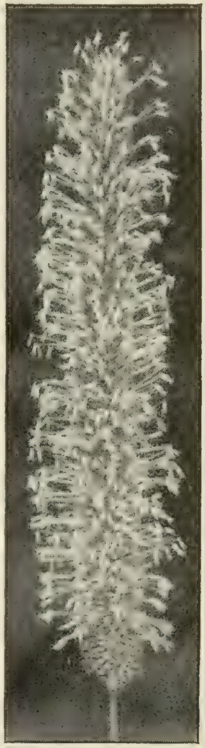
FIG. 96.—*Timothy head in full bloom*

Third cutting: When the seeds were formed, or when the bloom had all been shed, usually about July 1.

Fourth cutting: When the seeds were in the dough, about July 8.

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* Waters, H. J. Proceedings of the 31st Annual Meeting of the Society for the Promotion of Agricultural Science. 1911. Pp. 71–98.

Fifth cutting: When the seeds were ripe but not shattered, about July 16.

The experiments with timothy cut at these five different periods were conducted for five years and the results should thus be reliable.

The most suggestive and important point to consider first is the yield per acre of dry matter. The results are shown in the following table quoted from President Waters' paper:

TABLE 4.* YIELD OF DRY MATTER PER ACRE — ACTUAL AND RELATIVE. AVERAGE OF ALL TRIALS

Stage of development	Yield of dry matter per acre (pounds)	Relative yield
First cutting, coming into blossom	3,411	83.41
Second cutting, full bloom	3,964	96.93
Third cutting, seed formed	4,089	100.00
Fourth cutting, seed in dough	4,038	98.75
Fifth cutting, seed ripe	3,747	91.63

* Quoted from President Waters' Table II.

It will be seen that the third cutting, when the seeds were just formed and the bloom had all been shed, gave the largest yield of dry matter per acre. The reader will be interested in knowing that this cutting also gave the largest yield of field-cured hay per acre. The relative yield of field-cured hay per acre in each case followed the same order as the yield of dry matter per acre.

The next most important factor in determining the value of the different cuttings is shown by the relative yields of nutrients per acre. These are given in Table 5.

It will be seen from this table that the protein, ether extract (oils and fat), and crude ash were obtained in highest per cent in the second cutting, while the nitrogen-free extract and the crude fiber reached their greatest quantity per acre in the fourth and third cuttings respectively.

In order to obtain a still more rational view of the value of the hay cut at different periods, we still need to know the yield of the digestible nutrients per acre, which is shown in Table 6.

It will be seen from this table that the timothy hay had reached its maximum of digestible dry matter, protein, nitrogen-free extract, crude fiber, and ash at the time of the second cutting, while the maximum yield of digestible ether extract, or fat, was not reached until the fourth cutting.

TABLE 5.* AVERAGE YIELD OF NUTRIENTS PER ACRE — ACTUAL AND RELATIVE

Stage of development		Protein		Nitrogen-free extract		Crude fiber		Ether extract		Crude ash	
		Actual yield per acre (pounds)	Relative yield per acre	Actual yield per acre (pounds)	Relative yield per acre	Actual yield per acre (pounds)	Relative yield per acre	Actual yield per acre (pounds)	Relative yield per acre	Actual yield per acre (pounds)	Relative yield per acre
1st cutting	Coming into blossom	260.9	89.2	1,634.5	80.4	1,181.0	79.8	112.1	91.3	221.8	86.1
2d cutting	Full bloom	**292.6**	**100.0**	1,952.6	96.1	1,337.9	90.4	**122.9**	**100.0**	**257.7**	**100.0**
3d cutting	Seed formed	271.1	93.0	1,983.9	97.6	**1,479.4**	**100.0**	111.0	90.3	237.9	92.3
4th cutting	Seed in dough	252.8	86.4	**2,032.9**	**100.0**	1,428.9	96.6	110.1	90.1	212.1	82.3
5th cutting	Seed ripe	218.6	74.7	1,876.9	92.3	1,342.8	90.8	87.2	70.9	221.4	85.9

* Quoted from President Waters' Table III.

TABLE 6.* YIELD OF DIGESTIBLE NUTRIENTS PER ACRE — ACTUAL AND RELATIVE.— AVERAGE OF ALL TRIALS

Stage of development		Dry matter		Protein		Nitrogen-free extract		Crude fiber		Ether extract		Ash	
		Pounds per acre	Relative yield	Pounds per acre	Relative yield	Pounds per acre	Relative yield	Pounds per acre	Relative yield	Pounds per acre	Relative yield	Pounds per acre	Relative yield
1st cutting	Coming into blossom	1,995.6	92.5	134.6	91.7	899.3	82.8	777.0	99.4	42.7	79.0	77.1	92.9
2d cutting	Full bloom........	**2,156.3**	**100.0**	**146.9**	**100.0**	**1,085.6**	**100.0**	**781.4**	**100.0**	44.2	81.8	**83.0**	**100.0**
3d cutting	Seed formed.......	2,038.8	94.5	113.3	77.1	1,040.5	95.8	761.7	97.5	50.9	94.1	69.8	84.1
4th cutting	Seed in dough......	1,913.7	88.7	98.0	66.7	995.5	91.7	699.9	89.6	**54.1**	**100.0**	67.4	81.2
5th cutting	Seed ripe..........	1,774.8	82.3	91.9	62.6	892.6	82.2	683.1	87.4	37.5	69.4	63.0	75.9

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* Quoted from President Waters' Table V.

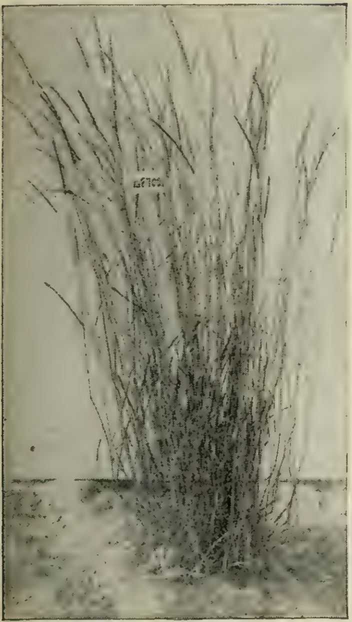
Clearly, however, so far as the total nutrient materials are concerned, the plants had reached their maximum yield per acre at the time of the second cutting.

President Waters also tested the palatability of the hay as affected by time of cutting, using cattle and to some extent sheep. Cattle having no other food than timothy hay clearly selected the hay in the order in which it was cut, preferring the first cutting. When fed liberally on grain and silage during the test, they did not show such decided preference for the early cuttings. Fat wethers given all the corn they would eat showed no apparent preference between the different cuttings. The experiments demonstrated that in general the early cuttings were the most palatable.

President Waters has given us definite data showing that the largest yield per acre of digestible nutrient materials is obtained by cutting timothy when in full bloom (Fig. 96) and that the largest yield per acre of field-cured hay, as well as of actual dry matter, is obtained from cuttings made when the seeds were just formed, an early "milk" stage immediately after the bloom had all fallen. In each of these stages a larger yield per acre was obtained, from both the standpoint of gross weight of material and that of actual nutrients, than was obtained from earlier or later cuttings; and, while apparently not quite so palatable as when cut at a still earlier period, it would seem in general that we may conclude that the proper time to cut timothy is between the time of full bloom and the period when the blooming has just passed and the seeds are in an early stage of development, the second and third cuttings in President Waters' experiments.

Plate I

An experimental field of individual timothy plants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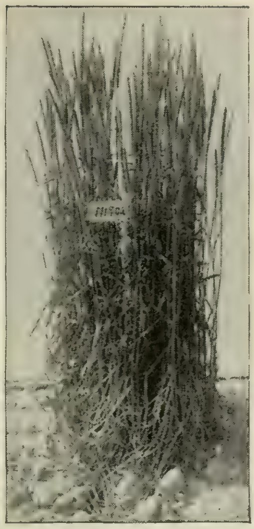
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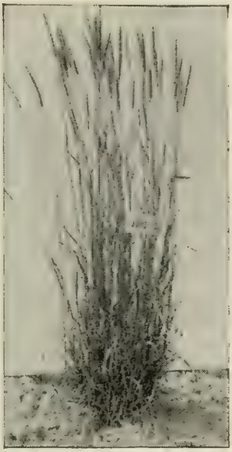
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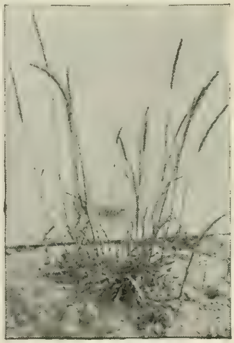
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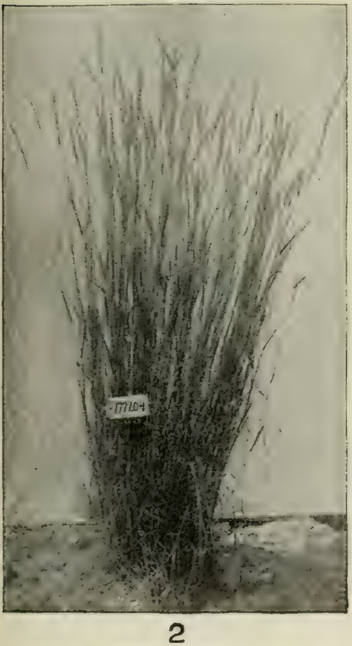
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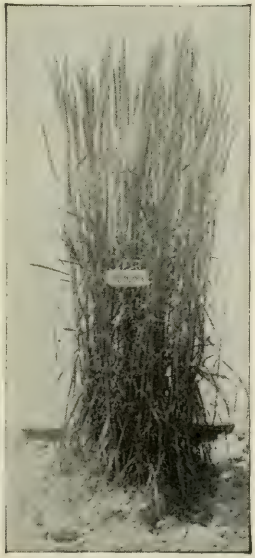
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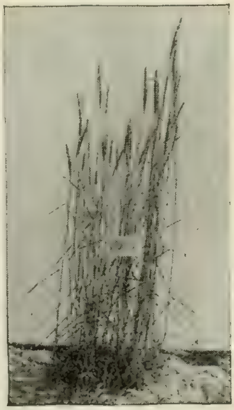
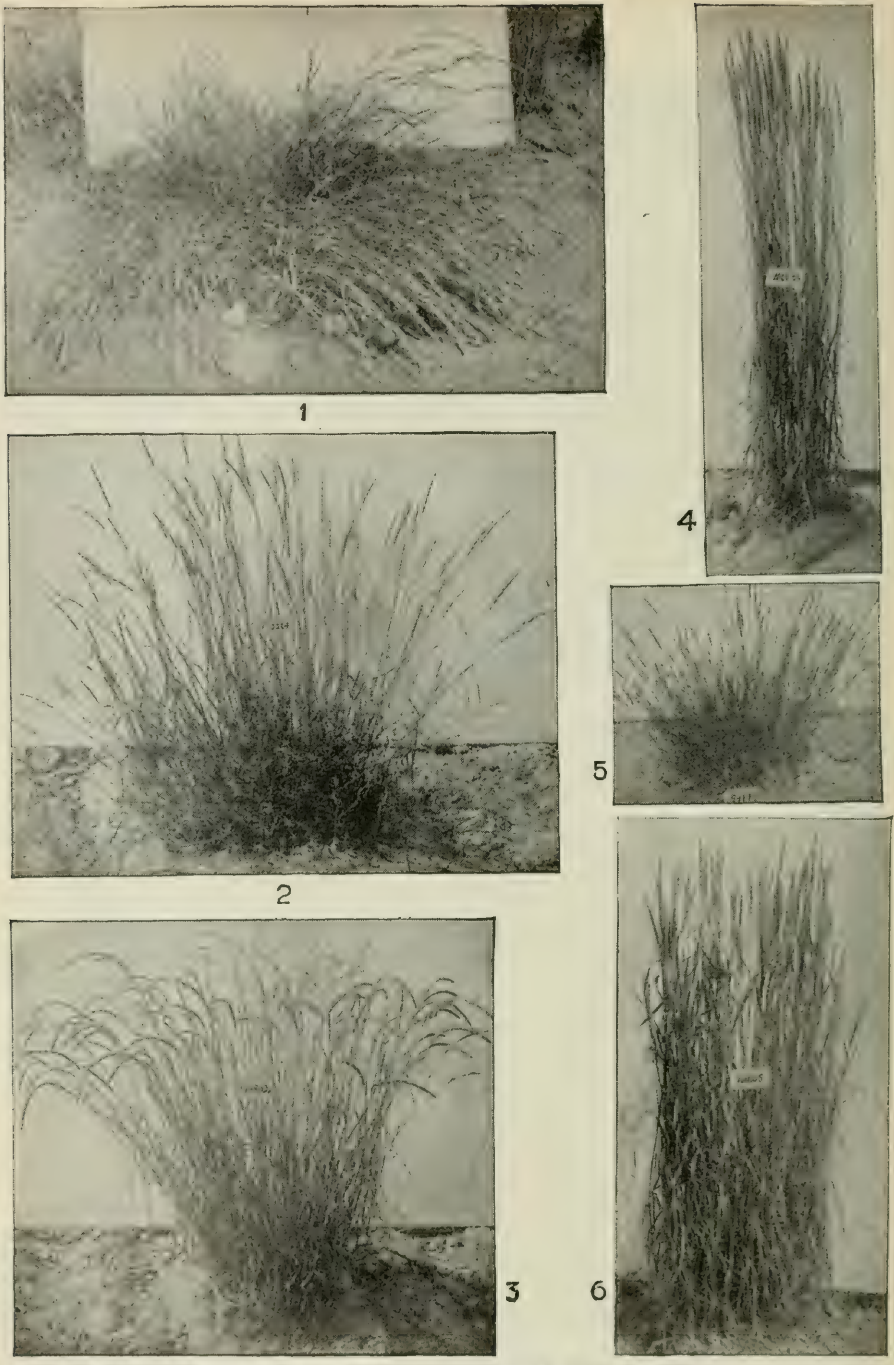
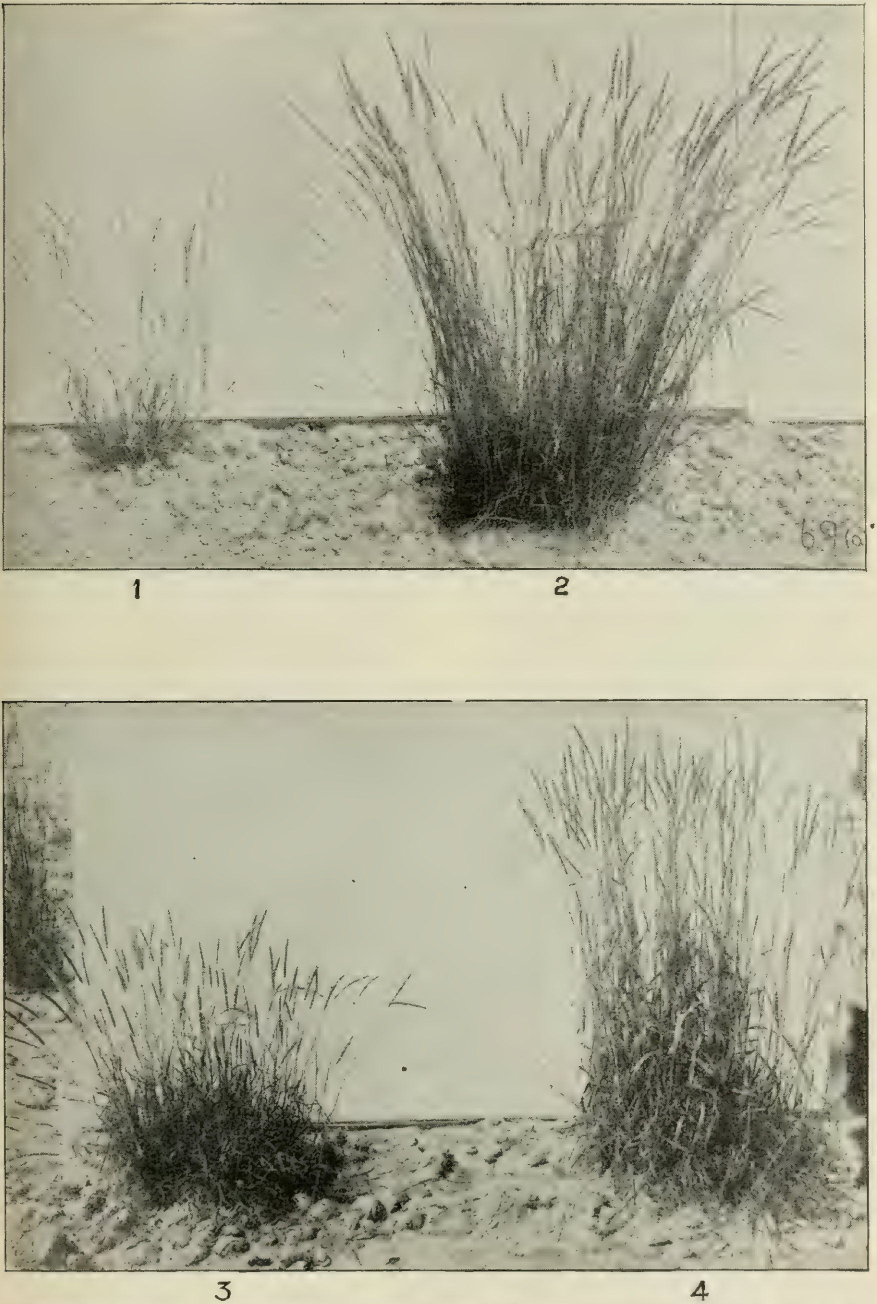

7

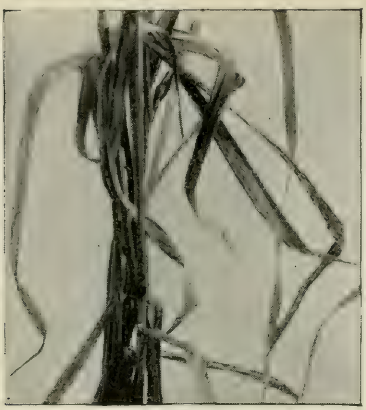
Types of timothy plants: 1. Plant 1687.02, tall and open, with few leaves, which are markedly reversed. 2. Plant 1777.04, very tall and erect, moderately dense, erect leaves, a good type. 3. Plant 1719.02, very dense, strikingly erect, late, very leafy, a good type. 4. Plant 1676.04, very erect, columnar, dense and leafy, a good type. 5. Plant 1792.02, of medium size. 6. Plant 1791.05, a low dwarf type with large heads. 7. Plant 1800.06, a small, low plant with fine stems. (All of the same age and comparative size)



Types of timothy plants: 1. A plant showing lodging habit. 2. Plant 1733.01, a very broad, low plant, of semi-lodging type with short and narrow leaves. 3. Plant 1748.02, a medium low plant, spreading outward above and with large nodding heads. 4. Plant 1666.01, a very tall, erect, and slender type. 5. Plant 911.17, a dwarf type (Phleum pratense, medium). 6. Plant 1611.05, tall, columnar, dense, leafy type with long and broad leaves, a good type. (All of the same age and comparative size)



Large and small timothy plants of different types growing side by side in field and in each case from same lot of seed. Small plant in lower figure a true dwarf type similar to variety medium. (Plate III, Fig. 5)



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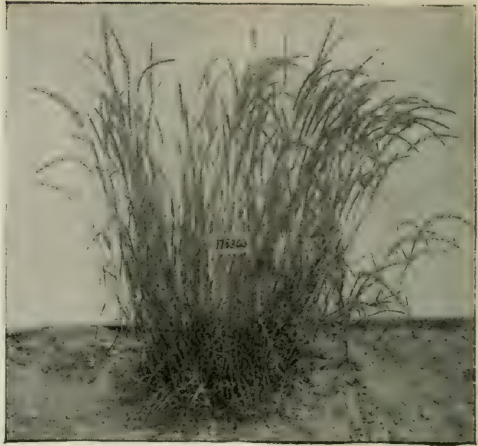

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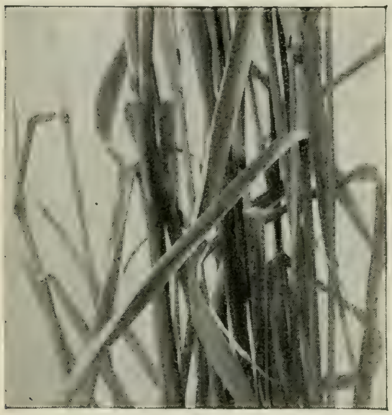

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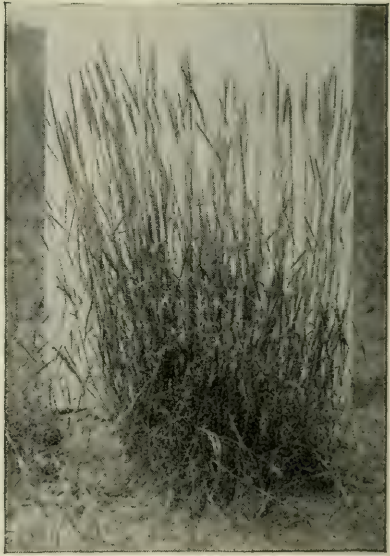

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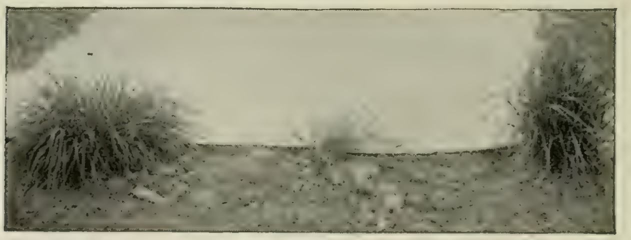


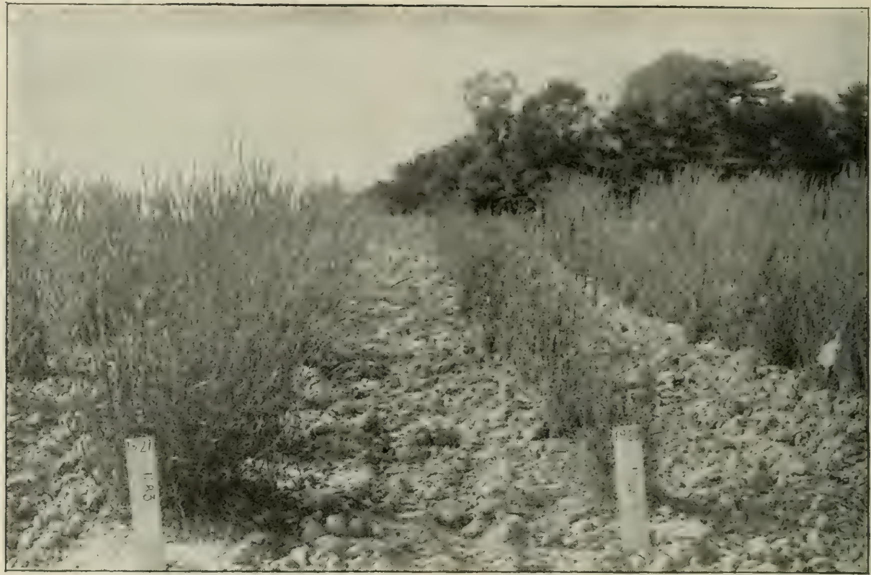
5

Timothy variations: 1. Leaves and stems from badly rusted type. 2. Leaves and stems from adjoining row of rust-resistant type. 3. Plant 1783.03, a broad, low type with large panicled heads. 4. A very broad, thick plant. 5. Three individuals in spring condition, showing variations in size and form of bunches

1

2

Rows of individuals propagated as clonal varieties: 1. Two good rows in center, Nos. 1611 and 1612, with ordinary row on right, No. 1613, and poor, badly rusted row on left. 2. In center, a large, nodding-headed row, No. 1748, with good, erect, columnar row on left, No. 1747, and large-yielding, semi-lodging row on right, No. 1749



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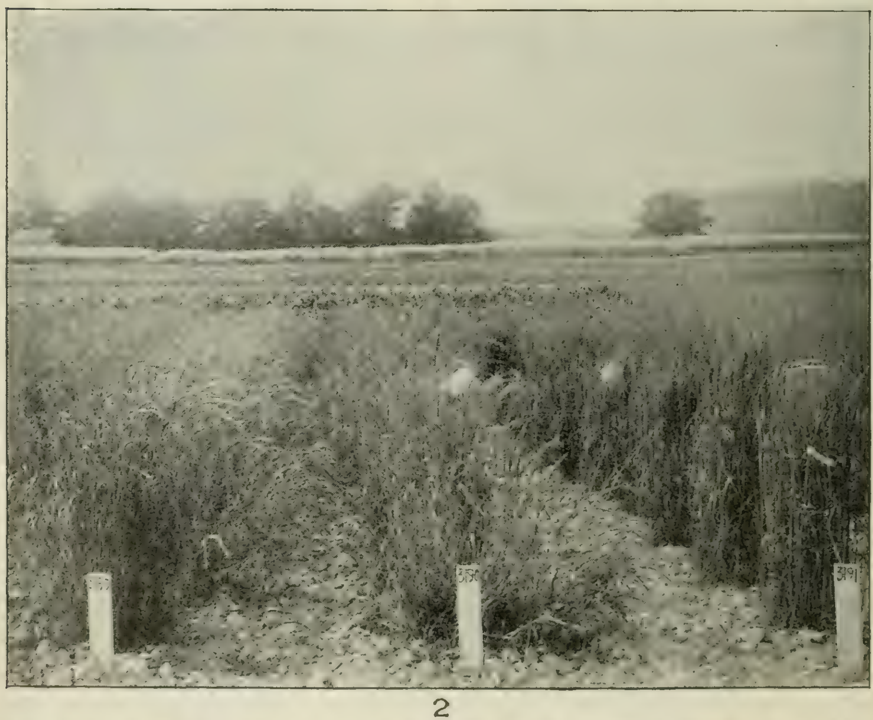
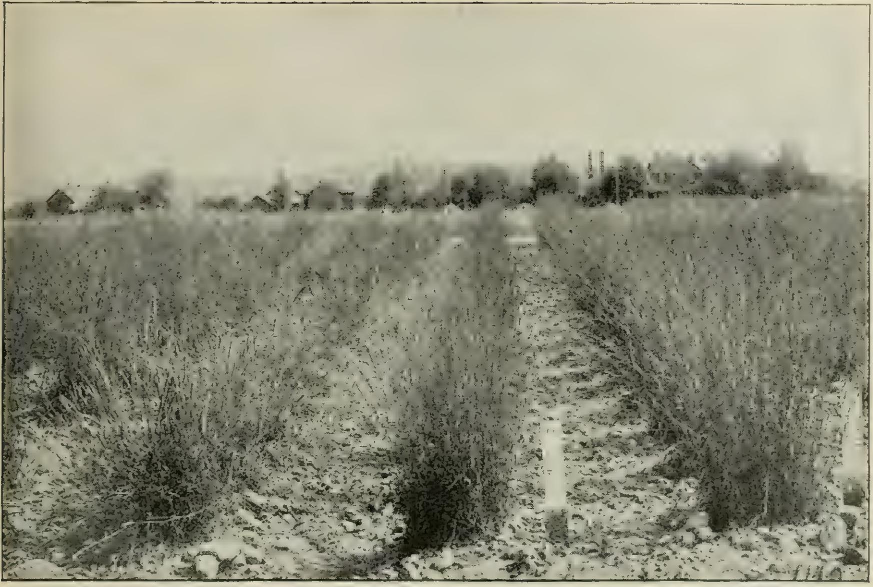


2

Rows of timothy showing inheritance of type by seed propagation: 1. *Row on right, No. 1920, a short, dwarfish type; row on left, No. 1921, a broad, moderately tall and large type; both from inbred seed and reproducing true to type.* 2. *Row on left, No. 3189, a clonal row of a semi-lodging, nodding-headed type; center row, No. 3190, inbred seed row of the same type as the preceding but somewhat reduced in vigor; row on right, No. 3191, a tall, erect, columnar type from inbred seed of plant shown in Plate II, Fig. 4*



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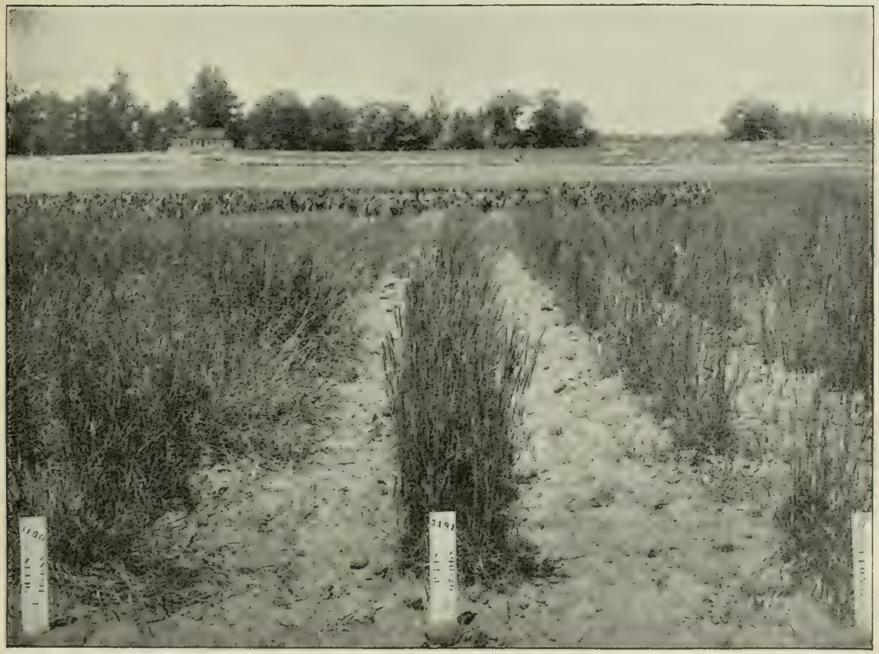

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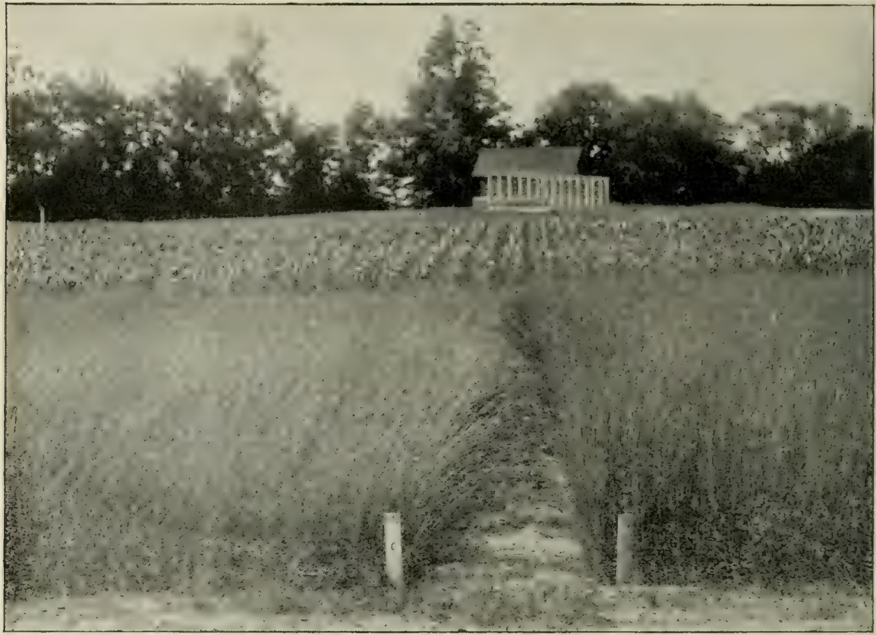
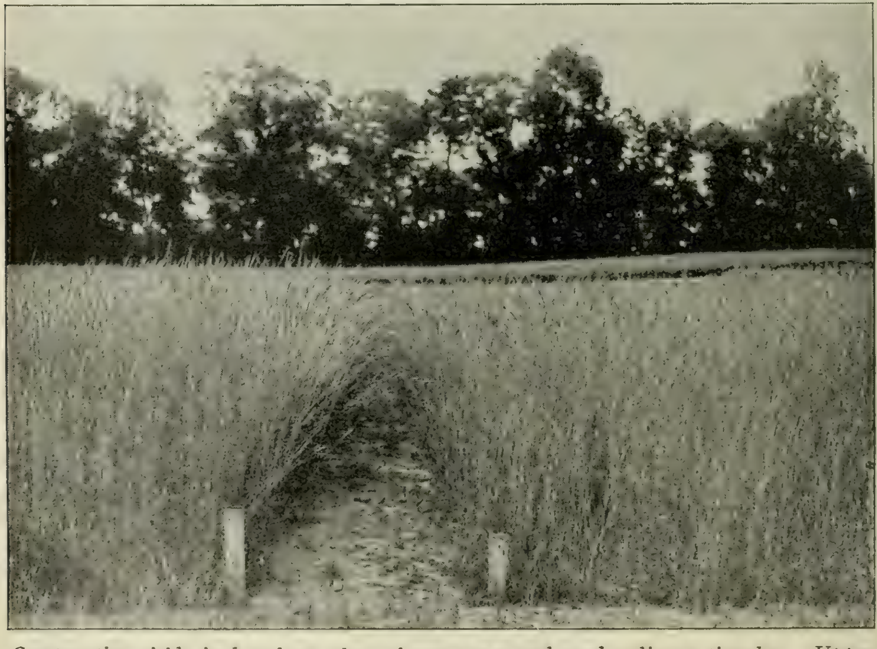
Rows of timothy showing inheritance of type by seed propagation: 1. Row on right, No. 3148, a good, upright, heavy-yielding type, reproduced as clonal variety; center row, No. 3149, the same type as preceding, grown from selfed seed; notice the similarity in type of the two rows and the smaller size of the one from selfed seed; row on left, grown from selfed seed of a large, semi-lodging type; notice uniformity of plants in this row. 2. Row on left, No. 3190, grown from selfed seed of a large, semi-lodging type; center row, No. 3191, grown from selfed seed of a large, upright, very dense type; row on right, No. 3192, a clonal row of a light-yielding type





Comparative yields in broadcast plats of new types and good ordinary timothy: Upper figure, on left, check plat No. 1835, good ordinary timothy; on right, new race, plat No. 1834; lower picture, on left, new race, plat No. 1848; on right, check plat No. 1847, good ordinary timothy

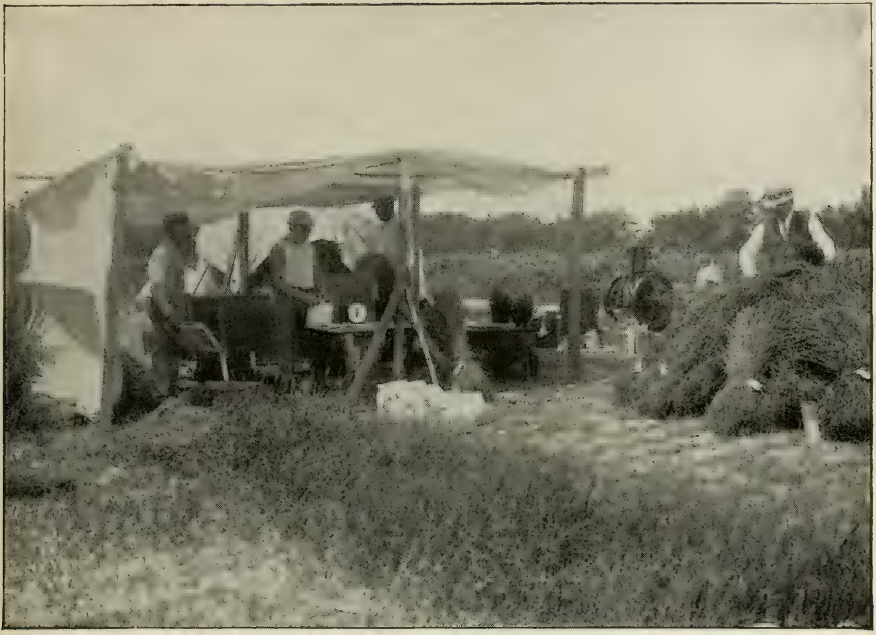


Fig. 1.—*Threshing bundles of timothy from experimental plats*

Fig. 2.— *Method of harvesting experimental plants*

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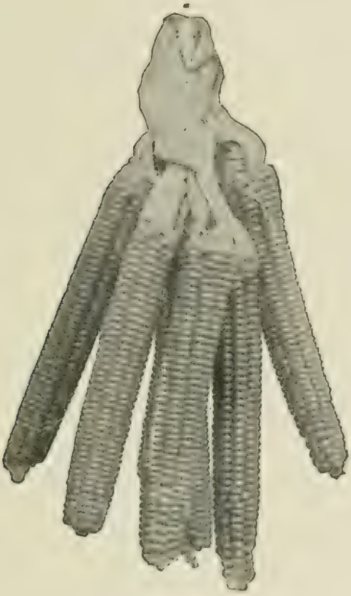
COOPERATIVE TESTS OF CORN VARIETIES



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COOPERATIVE TESTS OF CORN VARIETIES

EDWARD R. MINNS

Indian corn was cultivated in the region now constituting New York State long before Europeans took possession of the country. It is the oldest cultivated farm crop of the State, but by no means the most important one at present. Crop statistics published by the United States Department of Agriculture indicate that forty-six years ago (1866) the acreage, production, and value of corn for New York were larger than in any recent year. Development of the large corn-producing areas of the Mississippi Valley following the close of the Civil War, and decline of prices for farm products prior to 1900, brought the production of corn in New York to a low figure in 1898. Since that time the rising price of corn and the increasing importance of silage as a feed for dairy cattle have stimulated corn production. The acreage planted has not increased so much as have the rate of yield and the price.

Increased yields of corn in recent years are probably due to more intensive cultivation of farm lands adapted to corn, to the introduction of large late-maturing varieties solely for silage purposes, and, to some extent, to the influence of favorable seasons. The increased cost of dairy feeds of all kinds is making greater the necessity of home production of corn for economical feeding. There is a strong incentive to grow more and better crops of corn for feeding on the farm.

The Crop Reporter for December, 1911, states that according to official estimates of the acreage of corn harvested for silage in New York last year, the yield from 36 per cent of the area planted was stored in silos. Prior to 1875 silos were not used in this country. Their popularity among milk producers has modified the problem of corn production for the State to a large extent, so that much of the seed corn planted is produced in more favored climates outside the State.

Dent and flint varieties constitute the two types of field corn grown in the State. Both types are used for silage purposes, but the dent varieties are more popular. A few dent and many flint varieties are matured for grain and for stover.

New York farms have a variety of soil types, a considerable range of altitude, and a rather wide latitude. Soil conditions can be chosen and modified to suit corn culture to a large extent, but climatic factors cannot be changed. A proper selection of varieties and the improvement of acclimated strains of corn must be the method followed, if the corn grower would succeed under the varying conditions found in different localities about the State.

Although corn is a valuable product in New York, yet it is outranked by three other field crops: hay, oats, and potatoes are more valuable from a money standpoint. The growing of corn, however, will always be of local importance in many sections, especially where milk is being produced. Some favored sections of the State can also grow seed corn for localities where productive varieties do not ripen with certainty. Under prevailing economic conditions it seems likely that we may slowly increase the acreage planted to corn by determining which of the numerous varieties now grown in the State are best adapted to certain localities. It is more likely that the yields will be increased by selection of the best-known varieties for different regions, after testing all the varieties that are acclimated to various parts of the State.

EXPERIMENTS WITH VARIETIES OF CORN

The New York State College of Agriculture began a limited number of corn-variety tests in different parts of the State in 1909. A corn show was held at the College during Farmers' Week in February, and prizes were offered for exhibits in several classes. Over four hundred entries were made by persons residing in different parts of the State. Many of these were varieties of unknown origin and were not accompanied by a variety name. Because a large number of the exhibits were good and showed a considerable variation in type, it was decided to test forty-two of them in several different localities. The selections included both flint and dent varieties. In addition, four dent varieties furnished by the Cornell University Agricultural Experiment Station and four varieties from Bloomington, Ill., were tested, making fifty varieties in all.

The general plan of these tests was cooperative and they have been continued, with yearly modifications, for three years under the direction of Professor Paul J. White.* Many of the varieties were eliminated after a trial of one season; a few have been tested each year at several places. Some additional varieties were introduced at one or more localities in the second or third year of the tests. At four places the variety tests have been made for three successive years; the other localities have tested for one or two years the varieties furnished by the College. Tests have been made on farms belonging both to public institutions and to private owners. The location of the tests has ranged from the most favored corn-growing region of the State to regions of inferior soil and unsuitable climate at an elevation of 1,900 feet above sea level. These tests have, of course, met with varying seasonal conditions.

With the foregoing facts in mind, it will be understood that the results obtained cannot be summarized and averaged with any reliability for the whole State or for any considerable part of it. This bulletin is written with the purpose of presenting the most important results obtained in the several localities. The best variety of corn, or even the question of choice between flint and dent varieties as classes, must be determined locally; but a study of the results given herewith will indicate that a few of the varieties tested have shown adaptability in several different places.

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*Agronomist at Washington State College since September 1, 1911.

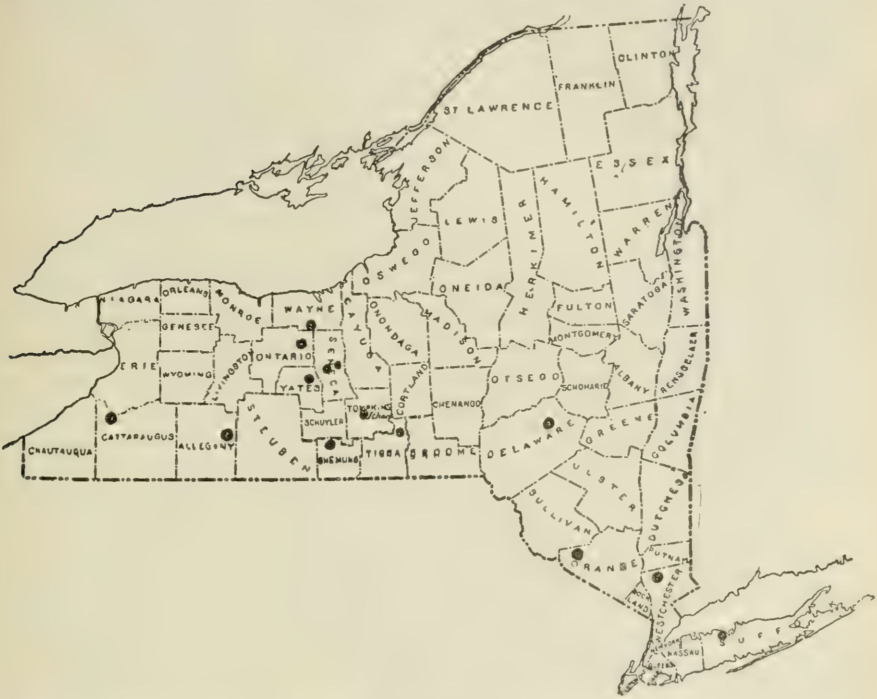

Fig. 97.—*Map of New York State showing the location of cooperative experiments described in this bulletin*

In order to present to the best advantage the experimental results obtained, the author has summarized the results for those localities in which the most important tests were made for more than one year; for variety tests made but once in a given place, the results are either reported separately or combined in tabular form with those from other places.

Experiments at Ithaca

Variety tests were made in 1909 and 1910 on the Dunkirk clay loam soil of the Cornell University farms. The field used for the first test was in a good state of cultivation; a much less fertile field was used for the second test. Drought interfered with growth of the corn both seasons.

The elevation above sea level is about 900 feet and killing frosts are likely to occur before October 1.

The plan of the experiment was typical of all tests made, so details may be given here. Rows were planted across the plat so that as nearly as possible all varieties had an equal chance. Each variety to be tested was given a consecutive number in each separate test. Beginning on one side of the plat with variety No. 1, a row of each variety was planted as numbered. Then the series was repeated in order to have duplicate rows of each variety in the experiment. In harvesting the corn and fodder the weights of both rows of each kind were taken together as the result for that variety. The yields of air-dried corn and field-cured stover were determined at Ithaca, but this was not done uniformly for all other experiments.

Fifty varieties were planted in 1909; five of these failed to grow here or in any of the other tests. The four dent varieties procured from Illinois did not mature here or elsewhere in the tests. In 1910 twenty varieties were tested. Eighteen of these were tested the first year, and two the second year only. Beside these two varieties, only those from which results were secured for two years are shown in the table below:

TABLE 1. YIELDS FROM CORN VARIETIES GROWN AT ITHACA

	Grain (bushels per acre)			Stover (tons per acre)		
	1909	1910	Two-year average	1909	1910	Two-year average
Flint varieties						
Hall's Gold Nugget	48.2	22.3	35.3	3.33	1.48	2.40
King Philip	50.0	20.8	35.4	2.10	1.35	1.73
Twelve-rowed White	38.8	17.6	28.2	2.66	.62	1.64
Canada Smut Nose	45.4	13.5	29.5	2.30	.48	1.39
Dutton	35.3	17.8	26.6	2.38	.82	1.60
Twelve-rowed Red	40.0	12.8	26.4	2.12	.40	1.26
Eight-rowed Yellow	39.5	16.0	27.8	2.70	......	....
Sanford White	37.1	14.1	25.6	2.93	.61	1.77
Dent varieties						
Stony Kill White Cap	44.6	17.4	31.0	3.56	.52	2.04
Shenandoah Special	47.5	12.6	30.1	2.23	.53	1.38
Onondaga White	43.4	17.8	30.6	2.45	.47	1.46
Pony Dent	36.6	22.9	29.8	1.70	.60	1.15
Michigan Dent	41.1	9.0	25.1	1.71	.44	1.08
Pride of the North	32.6	16.1	24.4	1.26	.45	.86
White Pearl	......	19.1	......	......	.90	....
Yellow Dent	......	18.7	......	......	.81	....

The two varieties yielding the most grain in this experiment are flint varieties; one of these, Hall's Gold Nugget, produced the best average yield of stover also. A rather late dent variety, Stony Kill White Cap, produced a good yield of stover but did not equal the King Philip flint corn in yield of grain. It is evident that varieties of both flint and dent corn have some adaptability to Ithaca conditions. As a class the flint varieties outyielded the dent varieties by 3 per cent in grain and 26⅓ per cent in stover in this limited test.

Experiments at Delhi

For three years varieties of corn have been tested on the county farm at Delhi, N. Y. The soil is a gravelly loam near the Little Delaware River. The elevation is 1,400 feet above sea level. Drought during the first two seasons and an early killing frost the third season reduced the yields obtained in these tests. Fifty varieties were planted in 1909. Thirty-eight of these were harvested, and from them ten were selected for the second trial in 1910; two local flint varieties were added in this test. The third trial was made with eight varieties furnished by the College of Agriculture, four introduced from other localities, and thirteen purchased from local seed dealers whose varieties were intended mainly for silage corn. The tests were in charge of A. J. Nicoll, of Delhi, N. Y. Because the yields were measured on a different basis each year, it is not thought wise to make averages in the table:

TABLE 2. YIELDS FROM CORN VARIETIES GROWN AT DELHI

	Bushels corn per acre 1909	Bushels shelled corn per acre 1910	Pounds field-cured corn per acre 1911	Percentage moisture in ear samples 1911	Pounds uncured fodder per hill 1911
Flint varieties					
State Flint (local)	......	46.8	....	....	7.0
Sanford White	46	38.2	....	....	....
Hall's Gold Nugget	45	35.9	11,538	35.8	11.0
Fisher's White	......	34.9	....	....	....
King Philip	46	31.9	11,846	37.9	7.5
Canada Smut Nose	46	31.6	12,538	34.2	9.0
Eight-rowed Flint	38	33.2	13,615	28.3	3.5
Twelve-rowed Flint	......	......	14,000	28.1	3.5
Genesee Valley	40	......	11,692	34.8	9.0
Dent varieties					
Onondaga White	42	37.8	11,538	29.5	9.5
Michigan Dent	44	33.8	....	....	....
Pride of the North	27	26.6	9,692	29.8	4.5
Stony Kill White Cap	27	20.1	....	....	....

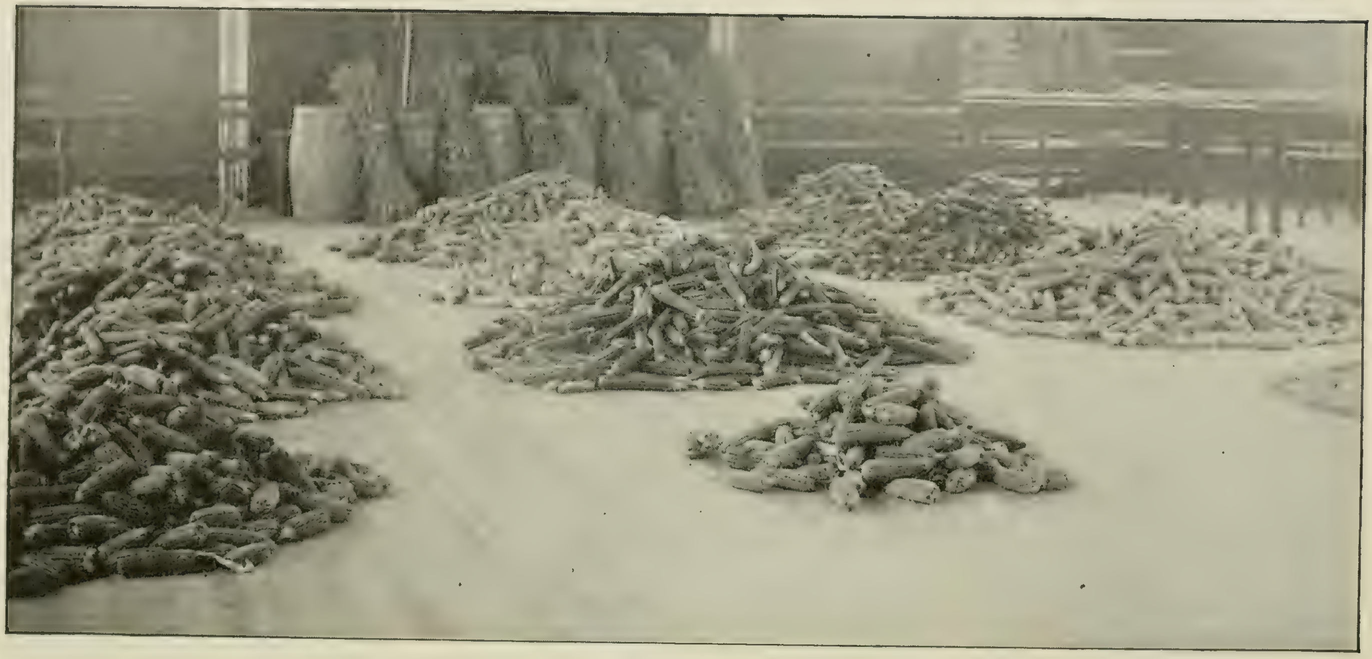

Fig. 98.—*The yields of some of the varieties of corn tested at Delhi, N.Y., in 1910*

The acclimated local yellow flint variety seemed to be superior to all others in the second test. In the third trial a twelve-rowed flint variety produced the largest and best-matured yield of ears. The flint varieties appeared better adapted to the climatic conditions at Delhi, but they varied somewhat in percentage of moisture. The moisture determinations were made on the best samples grown on selected plats and do not represent the immature condition of most of the varieties. The range in moisture content for some of the silage varieties was as high as 47 per cent. The weight per hill does not give a correct idea of the fodder produced by each variety, for when dry-matter determinations were made for single hills of a few varieties the range in dry-matter content was found to be from 22.2 to 44.4 per cent. Of the dent varieties, Onondaga White and a selected strain of Pride of the North came nearest to maturing in 1911. Several of the flint varieties matured each year and there is little doubt that if ripe corn is desired the early flint varieties should be grown. Those kinds that show the higher percentages of moisture have some adaptability for silage purposes; Hall's Gold Nugget appears to excel the others for silage. Some of the varieties grown for silage by farmers in that section showed at cutting time a high percentage of moisture. The best silage cannot be made from such immature corn fodder; more mature kinds will produce a larger percentage of digestible food, though the yield in tons of fodder may be less.

Experiments at Alfred

The farm of the New York State School of Agriculture at Alfred University is situated at an elevation of nearly 1,900 feet above sea level. The soil is known as Volusia silt loam. Neither soil nor climate is well adapted to corn growing, although some fields of corn are cultivated in that section. In order to ripen seed at Alfred, a corn variety must grow rapidly to maturity. Late planting combined with adverse weather conditions made the test a failure in 1909. Ten varieties were planted in 1910 and eight of these were harvested. Seven varieties were harvested in 1911, although none of them fully matured. The yields for two years are reported in Table 3 as field-cured ear corn and stover. The experiments were in charge of C. O. Du Bois, of the New York State School of Agriculture.

Except for silage purposes the dent varieties tested at Alfred are of no value. Only two of the flint varieties — Canada Smut Nose and Twelve-rowed — came near maturing in 1911 when early frost killed all varieties in September. It does not seem likely that a variety of corn can be obtained that will mature profitable crops of grain and fodder each year under the conditions at Alfred. Canada Smut Nose, or possibly King Philip, might do so in favorable seasons.

TABLE 3. YIELDS FROM CORN VARIETIES GROWN AT ALFRED

	Ear corn (pounds per acre)			Stover (tons per acre)		
	1910	1911	Average	1910	1911	Average
Flint varieties						
Canada Smut Nose	1,937	4,550	3,244	1.17	6.76	3.96
Eight-rowed	......	3,850	......	......	6.24	....
Hall's Gold Nugget	......	4,900	......	......	5.66	....
King Philip	3,148	3,990	3,569	1.85	4.88	3.36
State Flint	2,241	3,990	3,115	1.69	5.00	3.34
Twelve-rowed	2,260	2,660	2,460	1.17	3.67	2.42
Sanford White	2,583	......	......	2.30	......	....
Dent varieties						
Stony Kill White Cap	2,502	5,250	3,876	1.85	7.75	4.80
Michigan Dent	3,228	......	......	1.81	......	....

Experiments at Willard

The State Hospital Farm at Willard has a clay loam soil that can be made fairly good for corn growing. The elevation above sea level is 610 feet. Conditions are more favorable for corn production than at any of the places previously mentioned.

The season of 1909 was too dry for corn growing. Conditions were better in 1910, but planting was delayed until three weeks later than usual. Fifty varieties were planted in 1909. The field-cured ears of corn from forty-one of these were harvested and weighed, and ten were selected for further trial in the following season. Good yields of grain and stover were obtained in the 1910 trial. Four varieties from the 1910 test and a strain of Leaming corn were tested for silage fodder production in 1911. The results of this test are given in Table 9.

The yields of ear corn for 1909 and 1910 are given below. The experiments were in charge of Frank Warne, steward of the hospital.

Both flint and dent varieties are adapted to conditions at Willard, but very early varieties of flint corn are not so profitable as the larger and later kinds. Stony Kill White Cap and Hall's Gold Nugget seemed to be especially adapted for yields of grain and fodder. King Philip and Pride of the North were also good. The best varieties of dent corn should be used for the production of silage corn at this and similar places.

TABLE 4. YIELDS FROM CORN VARIETIES GROWN AT WILLARD

	Field-cured ear corn (pounds per plot) 1909	Shelled corn (bushels per acre) 1910	Field-cured stover (tons per acre) 1910
Flint varieties			
Hall's Gold Nugget	90	72.6	3.88
King Philip	62	70.0	2.01
Sanford White Flint	56	59.0	3.44
State Flint	54	49.5	2.57
Canada Smut Nose	50	50.7	2.12
Dent varieties			
Stony Kill White Cap	77	73.6	4.47
Pride of the North	92	63.4	3.65
Yellow Dent	72	58.3	4.08
Pony Dent	47	57.8	3.34
Michigan Dent	67	57.7	3.14

Experiments at Industry

The experiments at Industry were conducted by Erastus McPhee on a farm belonging to the State Agricultural and Industrial School. The farm is located in the Genesee River valley at an elevation of 540 feet above sea level, a region where conditions are favorable for corn growing. Fifty varieties were planted in 1909; thirty-five of these were harvested by husking the uncured ears from the standing stalks, which were then cut for silage. In 1910 nine of the best varieties were tested again, together with two additional varieties not tested here in 1909. All varieties reached maturity in the second trial and the yields were more carefully harvested. The results are found in the following table:

TABLE 5. YIELDS FROM CORN VARIETIES GROWN AT INDUSTRY

	Uncured ear corn (pounds per plat) 1909	Shelled corn (bushels per acre) 1910	Stover (tons per acre) 1910
Flint varieties			
Genesee Valley	184	46.2	1.81
Dutton	225	38.2	1.64
Hall's Gold Nugget	238	36.6	1.85
King Philip	....	31.2	1.80
Twelve-rowed White	217	26.3	1.65
Dent varieties			
Shenandoah Special	205	51.4	3.72
Leaming	....	43.1	2.92
Pony Dent	177	34.3	1.50
Stony Kill White Cap	257	33.0	2.35
Onondaga White	245	....	1.11

The flint variety showing the highest yield of corn in 1910 is a local strain of eight-rowed yellow flint corn. It is grown yearly for husking on the school farm at Industry. The best-yielding dent variety in 1910 has not succeeded in the other cooperative experiments. Dent varieties seem to be superior for conditions at Industry. Two dent varieties and two flint varieties were tested for silage fodder production in 1911. The yields are given in Table 9.

Experiments at Berkshire

The climatic conditions at Berkshire resemble those at Ithaca, but the soil on which the corn varieties were grown is better adapted to corn culture. A field of fertile gravelly loam at an elevation of 1,050 feet above sea level was used for a variety test in 1910. Twelve varieties were planted and of these ten were harvested; two dent varieties failed to mature. Very dry weather prevailed during the summer, but the cultivation given overcame that condition to a large extent. The experiment was made by D. P. Witter on his own farm. The grain only was weighed in harvesting. The yields shown in Table 6 are on the basis of corn containing 12 per cent of moisture:

TABLE 6. YIELDS FROM CORN VARIETIES GROWN AT BERKSHIRE

	Shelled corn (bushels per acre)
Flint varieties	
Hall's Gold Nugget	70.6
King Philip	69.7
Canada Smut Nose	61.0
Dutton	60.2
Yellow State Flint	59.1
Sanford White	47.8
Dent varieties	
Pride of the North	66.5
Michigan Dent	64.9
Onondaga White	60.9
Stony Kill White Cap	42.7

The varieties of flint corn made a higher average yield than did the dent varieties tested. Hall's Gold Nugget and King Philip gave better yields than did any other varieties. Pride of the North produced nearly as good a yield.

Experiments in 1911

A number of small cooperative experiments were located at various points in the State in 1911. Four of these were made on the farms of

State institutions. Several farmers were provided with seeds and directions for testing a few of the best-yielding varieties, but after harvest only five farmers made reports that would allow of a comparison with the results of other tests. Average yields for different varieties cannot be made, because the same varieties were not tested by all experimenters and conditions influencing the yields were not similar in all places. The size of plats used varied from 100 hills to 1,200 feet of row. The yields of ear corn and stover, together with elevation above sea level and date of planting, are shown in Tables 7 and 8:

TABLE 7. POUNDS OF EAR CORN FROM ONE PLAT OF EACH VARIETY BY LOCALITIES

	Kings Park	Otis-ville	York-town	Go-wanda	Ovid	Phelps	Penn Yan	Mc-Lean	Horse-heads
Elevation, feet........	125	850	500	665	600	700	.....	1,275	......
Date of planting......	June 10	May 23	June 3	May 26	May 16	May 18	May 16	May 18	May 31
Varieties									
Hall's Gold Nugget....	390	305	44	109	179	165	13	.....	170
King Philip..........	315	262	34	93	187	122	.....	92	133
Pride of the North....	294	305	57	107	245	....	25	76	140
Canada Smut Nose....	285	.....	31	71	.....	127	.....	.....	128
State Flint...........	179	.....	58	....	236	143	.....	.....	......
Wisconsin No. 7......	......	287	......	116	.....	....	18	.....	......
Mammoth Yellow Flint	......	.....	......	....	.....	122	12	96	......
Twelve-rowed Flint...	......	.....	125	....	.....	....	.....	52	......
Genesee Valley.......	......	49	......	....	.....	....	.....	.....	......
Pony Dent..........	......	.....	......	....	.....	....	.....	.....	122

TABLE 8. POUNDS OF STOVER FROM ONE PLAT OF EACH VARIETY BY LOCALITIES

	Kings Park	Otis-ville	York-town	Go-wanda	Ovid	Phelps	Penn Yan	Mc-Lean	Horse-heads
Varieties									
Hall's Gold Nugget....	390	435	117	133	113	125	33	.....	*10
King Philip..........	430	143	97	99	109	102	.....	278	9
Pride of the North....	445	247	115	86	105	....	43	228	12
Canada Smut Nose....	520	.....	101	47	.....	84	.....	.....	10
State Flint...........	385	.....	109	....	154	108	.....	.....	......
Wisconsin No. 7......	......	225	......	101	.....	....	39	.....	......
Mammoth Yellow Flint	......	.....	......	....	.....	106	27	280	......
Twelve-rowed Flint...	......	.....	......	131	.....	....	.....	120	......
Genesee Valley.......	......	.....	109	....	.....	....	.....	.....	......
Pony Dent..........	......	.....	......	....	.....	....	.....	.....	9

*Measured in bundles.

In these experiments all varieties except two produced good yields at one or more localities. No conclusion as to superiority of one

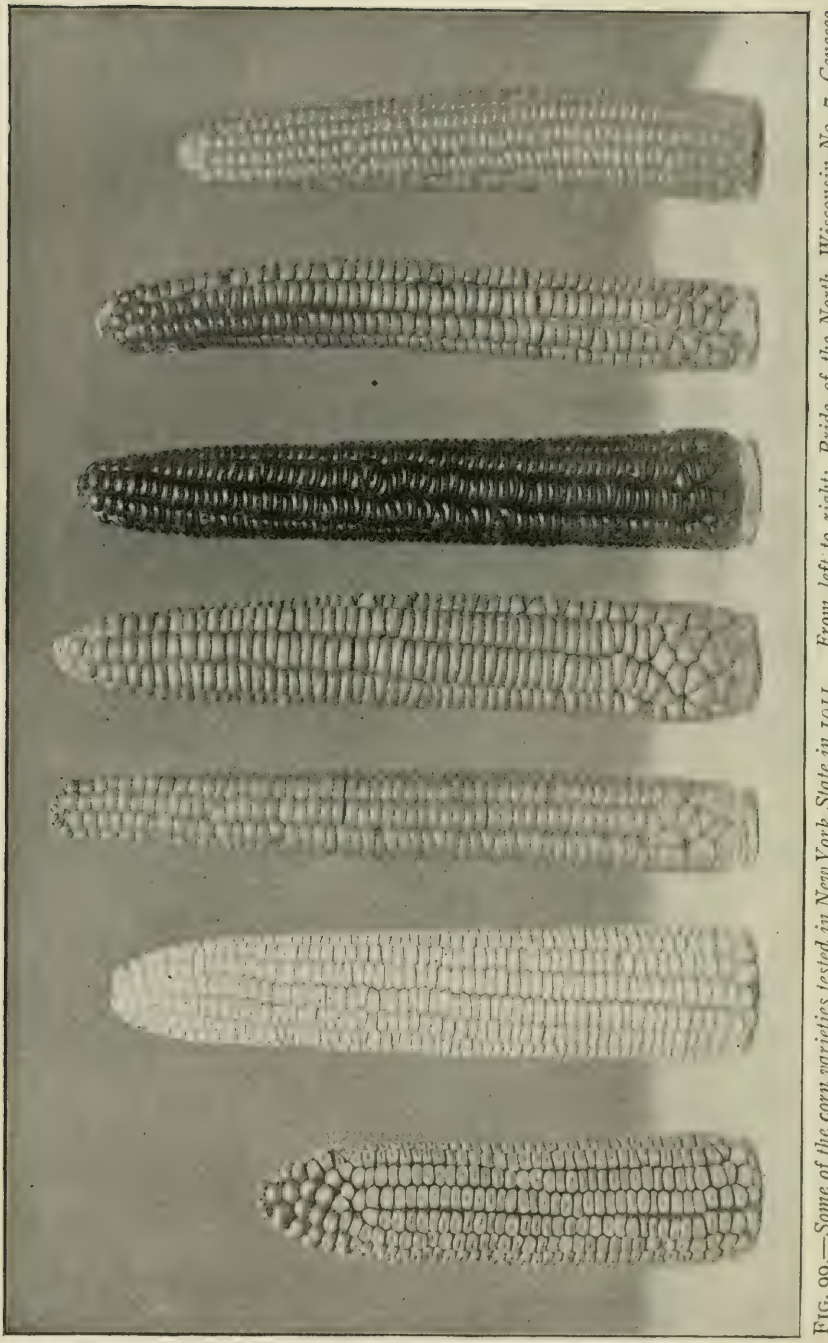

FIG. 99.—*Some of the corn varieties tested in New York State in 1911. From left to right: Pride of the North, Wisconsin No. 7, Genesee Valley, Hall's Gold Nugget, King Philip, Canada Smut Nose, Twelve-rowed Yellow Flint*

variety over another can be drawn from the varied results. It is evident that several of these varieties are well adapted to certain localities. The proportion of grain to fodder varies considerably when certain varieties are grown in different localities. This is most noticeable in the yields of grain and stover produced by the King Philip, Pride of the North, and Canada Smut Nose varieties as reported from Kings Park on Long Island and Gowanda in Cattaraugus county. It seems certain that the value of a variety of corn in this State is a matter that must be determined locally and not by averaging the results of any series of similar tests scattered over the State. As to the varieties of corn used in these tests, the results obtained seem to indicate that on suitable soils, and at less than 600 feet elevation above sea level, varieties of dent corn are as good as, or better than, the flint varieties for the production of ear corn and stover. Above 1,000 feet elevation varieties of flint corn are, as a class, better adapted to the climatic conditions and produce better average yields of mature corn.

Experiments with corn for silage

A few varieties of corn have been tested with a view to determining their ability to produce good silage fodder. For two years such tests have been made on the Cornell University farms under the direction of the writer. All the varieties in one test have been harvested at the same date and samples of the fodder analyzed for moisture content and nutrients. Additional tests of a few varieties were made at Willard and Industry, as previously noted. The yields of fodder for each kind and locality are shown below:

TABLE 9. YIELDS OF CORN FODDER FOR SILAGE FROM DIFFERENT VARIETIES IN THREE LOCALITIES

Variety	Willard (tons per acre) 1911	Industry (tons per acre) 1911	Ithaca (tons per acre) 1911	Ithaca (tons per acre) 1910
Hall's Gold Nugget	8.16	5.07	9.62	10.33
Pride of the North	9.82	6.88	8.73	7.23
Eight-rowed State	6.82	6.43	....	8.08
Stony Kill White Cap	11.50	5.99	....	....
Leaming	11.98	....	....	....
Wood's Northern White	....	....	....	10.82
Crossbred Yellow Dent	....	....	9.62	....
Eureka Ensilage	....	....	....	16.52
Blue Ridge Ensilage	....	....	11.84	....

Two of these varieties are of the flint type. Hall's Gold Nugget has shown adaptability for silage purposes in several of the experiments.

For a flint variety it produces a generous quantity of fodder containing a good percentage of grain. Pride of the North dent corn makes a very nutritious silage as grown at Ithaca, but the tonnage is rather low in comparison with other varieties. It is early enough to mature seed in many sections and where conditions are favorable will produce a fair quantity of fodder. Wood's Northern White, Stony Kill White Cap, and Leaming are later varieties that cannot be expected to reach maturity at Ithaca except in very favorable seasons. Eureka Ensilage and Blue Ridge Ensilage are southern-grown varieties and cannot be acclimated to New York conditions. The Eureka variety is grown for the silo by numerous farmers in New York, while the Blue Ridge variety is said to be very popular in northeastern Ohio. The former failed to produce any grain when grown at Ithaca; the latter produced immature ears.

A correct idea of the production of nutrients from each variety cannot be obtained without an analysis of the fodder at harvest time. The varieties grown at Ithaca have been analyzed by the Department of Agricultural Chemistry soon after harvesting in both years. These analyses and the weighed yields for each variety form the basis for the following table:

TABLE 10. YIELDS OF FODDER, DRY MATTER, AND NUTRIENTS FROM VARIETIES OF CORN GROWN FOR SILAGE AT ITHACA

	Tons per acre	Percentage dry matter	Pounds dry matter per acre	Pounds crude protein per acre	Pounds fat per acre	Pounds carbohydrates per acre
Season of 1910						
Pride of the North	7.23	32.51	4,703	442	163	3,145
Wood's Northern White	10.82	23.60	5,105	417	132	3,154
Eureka Ensilage	16.52	21.14	6,983	485	162	4,125
Eight-rowed State Flint	8.08	23.75	3,839	Partial analysis only		
Hall's Gold Nugget	10.33	25.40	5,249	444	155	3,318
Season of 1911						
Hall's Gold Nugget	9.62	32.20	6,194	550	148	4,079
C. U. Farm Crossbred	9.62	35.04	6,742	550	175	4,402
Pride of the North	8.73	32.75	5,718	592	164	3,838
Blue Ridge Ensilage	11.84	22.06	5,224	448	81	2,972

If yield of dry matter alone could be used as a guide to determine the best kind of silage corn to grow, the problem would be comparatively easy to solve; but the degree of maturity in corn fodder has been found to influence its digestibility and that of the silage made from it. The dry matter in very immature corn plants is less digestible and nutritious than in corn plants of the same variety that are nearly ripe. The percentage of dry matter is an index of maturity in unfrosted corn fodder. To make the best silage about 25 per cent of dry matter is required in the fodder; a percentage lower than 20 indicates immature corn, and one higher than 30 would hardly occur except in ripe or frosted corn fodder. In the 1910 experiment the Pride of the North variety was ripe, while the Eureka corn was in the milk stage. In 1911 the four varieties were allowed to stand for five days after a killing frost, before weights and samples were taken.

Differences in the amount of protein, fat, and carbohydrates produced are accounted for partly by variations in yield of fodder of the different varieties, and partly by variations in composition. In choosing a variety of corn to grow for silage, these variations should have some weight with other considerations.

Taking into account the yields of ear corn and of fodder produced by different varieties of both flint and dent corn in the cooperative experiments here described, we may say that for silage purposes it will be found best to grow varieties of dent corn wherever those varieties produce more than do flint varieties. The varieties should reach a fair degree of maturity in a normal season. At higher elevations and where flint varieties produce larger yields of ear corn and of stover, some of these varieties — such as Hall's Gold Nugget and King Philip — should be grown for silage in preference to the immature dent varieties that never become acclimated.

HOW FUTURE EXPERIMENTS SHOULD BE MADE

The experiments described in this bulletin indicate that varieties of corn suitable for different localities are now being grown in this State. The first step that should be taken in every locality where improvement in corn growing is desirable, is to test all varieties known to have some merit for that locality. Several farmers should make the same test in the same manner for one season. By comparing the results of such tests, the best varieties may be ascertained. These varieties should be retested, together with a few varieties from other sections in order to see if any better kinds can be introduced. The varieties that prove best adapted to the needs of the locality after continued testing through several seasons may then be improved by careful selection, and seed crops grown for distribution in the community by the person best equipped for it. This involves cooperation on the part of the corn growers, which will be likely to lead to other forms of community effort.

When desired, cooperative variety tests of corn may be made in those parts of the State where conditions warrant corn culture, under the direction of the State College of Agriculture. Directions for making tests and advice as to varieties most likely to succeed under certain conditions will be given on request. The College of Agriculture does not grow varieties of seed corn for sale or for general distribution. The varieties that should be tested are mainly in the hands of seedsmen and individual growers. An effort will be made to procure seed corn of the best varieties for trial under suitable conditions. From time to time a few varieties of proved merit should be sent out from the College to those localities where there is sufficient interest in corn growing. At this time we desire the cooperation of several persons in a locality for the purpose of testing corn varieties. A systematic study of all corn varieties grown within the State should be made with the help of the corn growers themselves, and the results published when the study is completed.

SUMMARY

A number of representative New York varieties of corn have been tested in cooperative experiments during the last three years. The most important results may be summarized as follows:

Elevation above sea level influences the climate of a locality to a large degree. The type of soil used is also of importance in corn growing. A high elevation, combined with a soil type not well suited to corn, caused failure or very poor results with some varieties acclimated to other locations that were more favorable. Better soils and lower elevations produced very different results, especially with dent varieties of corn.

For elevations of 1,000 feet or more above sea level, varieties of flint corn seem better adapted to produce ripe grain and stover than do dent varieties. For silage purposes there are a few good flint varieties and some early dent varieties that are preferable to very late dent varieties.

At elevations lower than 1,000 feet above sea level but above 600 feet, there are some flint varieties that can be depended on to yield better crops of sound mature corn than do dent varieties of equal earliness. For silage purposes there are both dent and flint varieties that are sufficiently productive and grow to reasonable maturity in a normal season.

For elevations lower than 600 feet above sea level, varieties of dent corn as a class will produce more satisfactory yields of grain and stover, or fodder for the silo. Early-maturing flint varieties are not productive enough for the lower elevations.

More thorough experimenting in localities where corn is an important crop are needed in order to determine the varieties best adapted for either grain or fodder production. All local varieties of corn should be tested by several persons during the same season, with such outside varieties as seem likely to succeed under prevailing climatic and soil conditions.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

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154 Tables for computing rations for farm animals
219 Diseases of ginseng
262 Apple orchard survey of Niagara county
265 On certain seed-infesting chalcis flies
266 The black rot of the grape and its control
272 Fire blight of pears, apples, quinces, etc.
273 The effect of fertilizers applied to timothy on the corn crop following it
277 The principles of brooding — The improved New York State gasoline-heated colony-house brooding system
280 Pastures in New York
282 Seven methods of feeding young chickens
283 The control of insect pests and plant diseases
284 Labor-saving poultry appliances
285 The cause of "apoplexy" in winter-fed lambs
286 The snow-white linden moth
288 Spray injury induced by lime-sulfur preparations
289 Lime-sulfur as a summer spray
291 The apple red bugs
292 Cauliflower and brussels sprouts on Long Island
293 The black rot disease of grapes
295 An agricultural survey of Tompkins county
297 Studies of variation in plants
298 The packing of apples in boxes
301 Sweet pea studies — I
302 Notes from the agricultural survey in Tompkins county
303 The cell content of milk
305 The cause of "apoplexy" in winter-fed lambs
307 An apple orchard survey of Ontario county
308 The plum leaf-miner
309 The production of "hothouse" lambs
310 Soy beans as a supplementary silage crop
311 The fruit-tree leaf-roller
313 The production of new and improved varieties of timothy

CIRCULARS

1 Testing the germination of seed corn
3 Some essentials in cheese-making
4 Soil drainage and fertility
6 Suggestions concerning treatment of seed corn with deterrents against crows
7 The relation of lime to soil improvement
8 The elm leaf-beetle
9 Orange hawkweed or paint brush
11 Helps for the dairy butter-maker
12 The chemical analysis of soil
(Department of Animal Husbandry) The formation of cow testing associations

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Department of Plant Pathology

FUNGOUS FLORA OF THE SOIL

By C. N. JENSEN

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FUNGOUS FLORA OF THE SOIL*

C. N. JENSEN

For many years the fungous flora of the soil has attracted considerable attention from various points of view. From a purely systematic standpoint, little has been known until recently of the species constituting a part of this flora, and little has been known of its biology and physiology. The present work is the outcome of investigations begun with a view to determine the extent of distribution of known pathogens in the soil and of their ease of isolation by cultural methods. Hence the systematic study and technic have been emphasized with a view to paving the way for more fertile biological and biochemical studies, as well as to serve as a basis for a monograph of the soil fungi.

The fungous inhabitants of the soil may properly be classified as obligate saprophytes and facultative parasites. In the determination of the obligate saprophytic forms, we must resort to the isolation of the forms by cultural methods only, while the determination of the facultative parasites may be carried on in two ways: one by isolation, the same as with the obligate saprophytes, and after isolation the determination of the pathogenicity of the form in question by a series of inoculations on the presumable host; the other, the reciprocal of this, by growing crops under controlled conditions and, in case disease due to parasitic fungi arises, in isolating the causal organism from the host.

The isolation of fungi from the soil is not so simple a task as at first sight it might appear. While it is true that we must consider the fungous flora of the soil as consisting of saprophytes, it does not follow that all these fungi will yield to one and the same cultural method or that they will grow on similar media. There must be a certain specialization as to food relations, temperature, moisture, oxygen, and so forth, with saprophytes as well as with parasites. This specialization must exist *a priori* in various degrees.

Every amateur student in mycology or plant pathology knows that if he wishes to collect a Pilobolus, a Sordaria, or a Chaetomium, he is most likely to find it on dung; in order to find *Pyronema confluens*, he looks for it on burned areas; again, certain saprophytes, such as the Cytosporas, grow commonly on dead twigs of the stone fruits, Salix, Populus, and the like. This specialization is recognized well in classification, as we often find groups of fungi designated by such words as fimicole, lignicole, caulicole, and so on. This being accepted without question, how readily should we expect to meet with considerable difficulty in isolating soil fungi, because of the lack of suitable media and other environmental factors! The acidity or alkalinity of the media, the kind of media as to nitrogen source, carbon source, and so forth, temperature, moisture, supply of oxygen, and various other factors determine to what extent cultural work ends in success.

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*Also presented before the Faculty of the Graduate School of Cornell University January 19, 1912, as a major thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Again, difficulty arises in taking the soil sample and in subsequently handling it so that contaminations are practically eliminated. There is no reason to presume that a fungus living saprophytically in the soil may not live elsewhere; in fact, the contrary is now known to be the case. If we are to speak of the fungous flora of the soil, no species should be grouped here unless evidence sufficient to substantiate the statement is at hand, because in this connection we are dealing with the very important item of habitat.

HISTORICAL

With the foregoing brief statements of some of the principal difficulties confronting the investigator of soil fungi, it has seemed desirable to give an historical review of the technic employed by previous workers in this field, together with their results, before taking up for consideration the writer's individual work.

Prior to 1886 there is practically nothing worthy of our attention, so far as isolation of soil fungi is concerned. Before that date it was generally recognized that the soil contained many of the lower fungi, but that was about the extent of the knowledge at that time. As to descriptions of species, there were probably very few of any value.

Adametz ('86) was the first real investigator who attempted to isolate soil forms and to give them names and descriptions. He isolated bacteria, yeasts, and molds, but we are interested only in that he isolated eleven fungi, among which were four yeasts (including *Monilia candida*). The purpose of his isolations was to obtain species for biochemical studies.

The soil samples used for his isolation work represented both sandy and loamy tilled land of the experimental fields. One sample was taken at the surface, and a second directly beneath at a depth of 25 to 30 cm. The original plan was to keep the fungi, isolated from the two kinds of soil, separate; but after some time this idea was abandoned because he found that the two soils harbored the same species.

The sterilized reagent flasks (including sterile media presumably, although this is not stated), closed with sterilized cotton plugs, were inoculated in the field where the samples were taken. Further details

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('86) Adametz, Leopold. Untersuchungen ü. d. Niederen Pilze der Ackerkrume. Inaug. Diss. 1–78. *pl. 2.* 1886.

with respect to taking the samples are not given, except the statement that the greatest precaution in all the work was constantly observed. The methods observed in sterilization of media, glassware, etc., were similar to those of Hueppe ('85), whom he followed closely.

Following Adametz we find Reinitzer, Nikitinsky, and van Iterson interested in the soil flora principally from the same standpoint, the isolation of species with a view to the study of the biochemical processes taking place in the soil. Reinitzer and Nikitinsky were primarily interested in the decomposition of humin substances by soil organisms, while van Iterson busied himself only with decomposition of cellulose.

Reinitzer ('00) extracted humin substances from garden, wood, meadow, and heath soils as well as from wood mold. The substances after extraction were never sterilized and were allowed to stand in dishes unprotected from the air. No fungous growth took place. Later these substances were inoculated with a small portion of wood soil containing hyphæ, but with only negative results. While valuable data of a biochemical nature resulted from his work, still as to isolation of soil fungi nothing new can be accredited to him.

Later Nikitinsky ('02) was somewhat more successful in the isolation of soil forms than was Reinitzer. He isolated some thirty forms of bacteria and three species of fungi. While his technic allows considerable room for contaminations, he undoubtedly isolated from the soil the forms mentioned by him, as they have been isolated repeatedly by other investigators since. For his isolation work he used three solutions as follows:

Solution I	Solution II	Solution III
1.5 per cent humic acid	1 per cent humic acid	1.5 per cent humic acid
———	0.5 per cent $(NH_4)_2SO_4$	———
———	———	0.2 per cent cane sugar
0.2 per cent KH_2PO_4	0.2 per cent KH_2PO_4	0.2 per cent KH_2PO_4
0.2 per cent $MgSO_4$	0.2 per cent $MgSO_4$	0.2 per cent $MgSO_4$

These solutions were placed in 1½-liter flasks, plugged, and sterilized in an autoclave at 120° C. for thirty minutes. After cooling they were inoculated with soil extract. The soil extract was obtained from garden soil as well as from the upper and lower layers of forest and humous soils. The humic acid used in the solutions was obtained from the two soils last mentioned.

('85) Hueppe. Die Methoden der Bakterienforschung. Wiesbaden. 1885.

('00) Reinitzer, F. Über die Eignung der Huminsubstanzen zur Ernährung von Pilzen. Bot. Ztg. **58**: 59–73. 1900.

('02) Nikitinsky, J. Über die Zersetzung der Huminsäure durch physikalisch-chemische Agentien und durch Mikroorganismen. Jahrb. Wiss. Bot. **37**: 365–420. *fig. 4.* 1902.

The cultures were allowed to stand ten days. Transfers were then made (exact method not stated) to culture solutions of the same composition as the original. These were again allowed to stand ten days and another transfer made. Finally, a third transfer was made. Ten days after, this third subculture was used for pouring dilution plates after the Koch method. The media used for pouring plates were normal gelatin (10 per cent gelatin, 10 per cent peptone, 0.2 per cent monopotassium phosphate [KH_2PO_4], 0.2 per cent magnesium sulfate [$MgSO_4$], 0.2 per cent glucose), agar (1.5 per cent agar, 1 per cent peptone, 0.2 per cent monopotassium phosphate [KH_2PO_4], 0.2 per cent magnesium sulfate [$MgSO_4$], 0.2 per cent glucose), and sodium humate mixed with gelatin. These pure cultures now obtained were used in Nikitinsky's biochemical studies. In a few instances cultures were obtained by inoculation of gelatin (without humic acid) directly with soil. Further details of this method are not given. The first method yielded mostly bacteria; one yeast is recorded. The second method yielded *Penicillium glaucum*, a Mucor, and a Trichothecium.

Coming now to van Iterson ('04), we find the following method of procedure: Two sterile pieces of Swedish filter paper were placed in glass dishes and these were moistened with tap water (leitungswasser) 100 cc., ammonium nitrate 0.05 gram, monopotassium phosphate 0.05 gram. As inoculation material he used soil or humus, but the best results were obtained when the dishes were left exposed to the air for twelve hours. Following inoculation of the plates they were maintained at 24° C. and the paper was kept moist. He states that after fourteen days to three weeks a rich fungous growth could be noticed. He now obtained pure cultures from these plates for his further study. The exact methods pursued are not given. The following species were isolated: *Sordaria humicola* Oud., *Pyronema confluens* Tul., *Chaetomium Kunzeanum* Zopf, *Pyrenochaeta humicola* Oud., *Chaetomella horrida* Oud., *Trichocladium asperum* Harz, *Stachybotrys alternans* Oud., *Sporotrichum bombycinum* (Corda) Rabh., *Sporotrichum roseolum* Oud. et Beijer., *Sporotrichum griseolum* Oud., *Botrytis vulgaris* Fr., *Mycogone puccinoides* (Preuss.) Sacc., *Stemphylium macrosporoideum* (Ben. Br.) Sacc., *Cladosporium herbarum* (Pers.) Link, *Epicoccum purpurascens* Ehren. It is unfortunate, from our point of view, that there is no mention made as to just which species were isolated from the soil and which species from the air.

The most extensive work as to the number of species isolated from the soil is that of Oudemans and Koning ('02). The isolation was carried out

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('02) Oudemans, C. A. J. A., et Koning, C. J. Prodrome d'une flore mycologique obtenue par la culture sur gelatine préparée de la terre humeuse du Spanderswoud près Bussum. Arch. Néerl. Sci. Nat. ser. 2, 7: 266–298. *pls. 41.* 1902.

('04) van Iterson, C. J. Die Zersetzung von Cellulose durch aërobe Mikroorganismen. Centbl. Bakt. u. Par. Abt. 2, 11: 689–698. *pl. 1.* 1904.

by Koning, while the classification of the species was made by Oudemans. Forty-five species were isolated and classified, and illustrations were made of practically all. All isolations were made from humous soil.

After considerable experimentation Koning found the following to be the best nutrient medium for use in culture work: wort 50 cc., water 50 cc., saccharose 2 per cent, gelatin 10 per cent or agar 1.5 per cent, always allowing the reaction of the medium to remain as it happened in preparation. However, this was always acid.

To begin his cultures, Koning introduced into a platinum capsule, heated to redness for sterilization and then allowed to cool, a fragment of humus, by preference the remains of a leaf of about 1 sq. cm. This humus was taken near the surface. He now poured about 1 cc. of sterilized water into the capsule, and by means of a glass rod (sterilized by flaming) triturated the fragment of humus. The bouillon thus obtained was introduced, with the aid of a platinum loop made to hold nearly 50 mg. of liquid, into a test tube containing 10 cc. of water. This dilution was the most advantageous, as taught by his experience. The contents of the test tube were now poured on the surface of plates poured with the nutrient medium given above. After clarification of the liquid — that is, after deposition of the spores, and so forth — the plates were inclined in order to allow the liquid to flow out. After a period of two days at 24° C., the colonies of molds were seen to develop. From these Koning obtained his pure cultures.

The following species were isolated: *Mortierella humicola* Oud., *M. isabellina* Oud., *M. pusilla* Oud., *M. subtilissima* Oud., *Mucor geophilus* Oud., *Absidia coerulea* Bainier (*Mucor Saccardoi* Oud.), *M. racemosus* Fres., *Pilaira anomala* (Ces.) Schröt., *Chaetomella horrida* Oud., *C. tortilis* Delacroix, *Sphaeronema Fagi* Oud., *Acrostalagmus cinnabarinus* Cda. var. *nana* Oud., *Amblyosporium echinulatum* Oud., *Arthrobotrys superba* Cda. f. *oligospora* Coemans, *Aspergillus calyptratus* Oud., *Aspergillus Koningi* Oud., *Botrytis vulgaris* Fr., *Cephalosporium acremonium* Cda., *C. humicola* Oud., *C. Koningi* Oud., *Monilia acremonium* Delacroix, *M. geophila* Oud., *M. humicola* Oud., *M. Koningi* Oud., *Monosporium silvaticum* Oud., *Naematogonium humicola* Oud., *Penicillium desciscens* Oud., *P. geophilum* Oud., *P. glaucum* Link, *P. humicola* Oud., *P. silvaticum* Oud., *Spicaria decumbens* Oud., *S. elegans* (Cda.) Harz, *S. silvatica* Oud., *S. simplicissima* Oud., *Trichoderma Koningi* Oud., *Alternaria humicola* Oud., *Bispora pusilla* Sacc., *Hormodendrum pallidum* Oud., *Stemphylium botryosum* Wallr., *Torula lucifuga* Oud., *Ciliciopodium Magnusii* Oud., *Graphium Klebahni* Oud., *Stysanus stemonites* (Pers.) Corda, *Stysanus difformis* Oud., *Tilachlidium humicola* Oud.

The brief history already given differs decidedly from that which follows, as a casual comparison will readily show. We note at once, in the consideration of the earlier history, that isolation was concerned with all fungi which might arise. The investigations that are now to be noted are limited to particular groups or species only, depending on whether the work is concerned with saprophytes or with facultative parasites.

Among the first to receive mention should be Butler ('07), to whom much credit is due for his excellent treatise on the genus Pythium. Although he does not deal with soil forms alone, yet his work must constitute a valuable part of the history that we are discussing, because of the species he has unquestionably shown to be soil organisms as well as the new method of isolation evolved by him. We can do no better than use the author's own words in the description of his method:

> Garden earth, preferably from the neighborhood of the roots of higher plants, is taken three to six inches below the surface of the soil and placed in a large shallow vessel to which enough tap water is added to leave a layer free above the earth. In this the substratum is floated. Numerous trials have shown that the nature of the latter is by no means a matter of indifference. . . . By far the best medium which I have found for general use is boiled sliced root of Abutilon, either plain or steeped in decoction of flies. . . . . Working in the tropics I have found it very useful to acidify slightly with citric acid the water used during the first step in the isolation from earth, in order to keep down bacteria. The acid often, however, interferes with spore formation, so that it is necessary to shorten the time as much as possible. After twenty-four hours, the culture substratum is removed and placed in a relatively large quantity of water, and after another twenty-four hours examined.

From a consideration of the above we are again forcibly reminded that there is considerable specialization as to food relations, and so forth, amongst soil organisms, and that different methods and media yield decidedly different results.

The species isolated by Butler are *Pythium de Baryanum* Hesse, *P. intermedium* de Bary, *P. vexans* de Bary, *P. proliferum* de Bary, *P. rostratum* Butler, *P. monospermum* Pringsh.

Following Butler are Hagem, Lendner, and Namyslowski. All three have confined their isolations to the Mucorales and many new species have been found. As a result of the work of the first two, especially, the demand has arisen for a new monograph of the order. This demand is supplied by Lendner's "Les Mucorinées de la Suisse," 1908. But even since that date these investigators have still isolated many new species, so that the monograph is now somewhat incomplete in that about nine new species are not considered within its pages.

('07) Butler, E. J. An Account of the Genus Pythium and Some Chytridiaceae. Mem. Dept. Agr. India, Bot. Ser. No. 5. **1**: 1–160. *pl. 10.* 1907.

Hagem ('08, '10) isolated the following eighteen species of Mucorales, nine of which are new to science: *Absidia Orchidis* (Vuill.) Hagem, *A. glauca* Hagem, *A. spinosa* Lendner (syn. *Mucor Norvegicus* Hagem), *Mucor Ramannianus* Möller, *M. hiemalis* Wehm., *M. strictus* Hagem, *M. mucedo* (Linné) Bref., *M. Christianiensis* Hagem, *M. dispersus* Hagem, *M. sylvaticus* Hagem, *M. flavus* Bainier, *M. genevensis* Lendner, *M. racemosus* Fres., *M. griseo-cyanus* Hagem, *M. corticolus* Hagem, *M. plumbeus* Bonord., *M. sphaerosporus* Hagem, *M. saturninus* Hagem. He has also isolated four species of Actinomyces. His work on the species of Actinomyces was instituted primarily in order to study the distribution of animal pathogenic forms. As yet he has not succeeded in connecting any pathogens with those found in his culture work. The paper "Untersuchungen über Norwegische Mucorineen, II" is principally a biochemical study having for its basis the species of Mucor isolated from the soil. Of interest to us in this connection is Chapter I, "Die Verbreitung der Mucorineen im Erdboden," in which a general discussion is given of the distribution of these fungi in various soils. The two other papers deal with descriptions of isolated species and technic. To Hagem must be given foremost rank among the investigators of soil organisms as to morphological as well as biochemical studies.

His soil samples were taken as follows:

> In order to investigate the Mucorale content of a soil sample, it is usually sufficient to sprinkle three to four petri dishes with small amounts of soil. The colonies spread very quickly over the substratum and must be transferred to new substrata again and again as soon as fructification begins. The smaller forms, as *M. Ramannianus* and *Zygorrhynchus Moelleri*, are very easily overgrown by larger forms, as *M. hiemalis*, and it is therefore appropriate to use a great number of plates and to inoculate each plate with a few small particles of soil.

Hagem has investigated, for their Mucorale content, different soils such as arable, meadow, garden, wood, and the like. To this end, either the samples of soil were taken at the locality and placed in sterilized reagent flasks and then brought to the laboratory, where petri dishes containing wort-agar were inoculated; or the dishes were taken to the field, where they were inoculated with small particles of soil transferred by means of sterile forceps.

The method of obtaining pure cultures is worthy of somewhat detailed description, particularly since so much is written concerning heterothallic species exhibiting homothallicism, and vice versa. It is quite possible

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('08) Hagem, Oscar. Untersuchungen über Norwegische Mucorineen **1**: 1–50. *fig. 22.* 1908. (Reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907.)

('10) ——— Untersuchungen über Norwegische Mucorineen **2**: 1–152. 1910. (Reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 4, 1910.)

('10) ——— Neue Untersuchungen über Norwegische Mucorineen. Ann. Myc. **8**: 265–279. *figs. 1–8.* 1910.

('10) ——— Einige Beobachtungen über die Verbreitung der Actinomycetes in der Natur. Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 197–205. 1910.

that the results of some workers can be attributed to cultures which are not the descendants from a single spore. The acute observer, and he who has worked with the Mucors to any extent, knows that it is no easy task to pour plates with spores distributed singly. Usually they adhere in twos and threes. Hagem is the first to warn us in print of this condition. His method of obtaining pure cultures from a single spore is based primarily on this fact and is as follows:

> With a platinum needle, some spore material is transferred to a flask containing about 30 cc. of sterile water. After vigorous shaking, one pours a few cubic centimeters of the spore-containing water into a second flask containing water, and again after vigorous shaking a few drops are transferred from the second flask to a third. After repeated shaking of this, 2 cc. are poured on the solid nutrient stratum of a poured petri dish and distributed over the whole surface. The spores are now allowed to settle and thereafter the water is carefully poured from the dish. The dish is now left at room temperature for two to five days, and when the spores have begun to germinate an attempt is made to isolate a colony. To do this, the dish is opened and brought quickly under the microscope (enlargement about 50). At a glance one detects whether the colony has originated from a single spore. Transfer is now made to the substratum of a second dish.

This operation of determining that a colony is the product of a single spore allows some possibility of contamination while the plate is left uncovered and during the observation. The chances of contamination are very slight, however.

The writer employs a method in vogue in the laboratory of the Department of Plant Pathology, Cornell University, which is probably somewhat more commendable than that of Hagem. This method can be used to advantage especially when pouring plates with spores as large as those of most species of Mucor. The method is as follows: Plates are poured so that a very thin layer of the solid nutrient medium covers the bottom of the dish. Inoculation of the plates is made after the Hagem method. After germination of the spores, instead of removing the cover of the dish, the dish is inverted and placed on the stage to make the observation. The glass immediately above the spore (this, of course, while the dish is inverted) is marked with india ink in order to assure no mistake in transfer of the proper colony.

Contemporary with Hagem in Norway, we find Lendner ('08) in Switzerland at work on a study of the Mucorales as to distribution, culture, classification, and so on. His studies have resulted in the admirable monograph already cited. In a study of the habitat of the species of this order, the author considers, in connection with a number of pabula, that of the soil. One species, *Mucor botryoides*, is not listed in the monograph but has been isolated from the soil more recently by Lendner ('10).

('08) Lendner, Alfred. Les Mucorinées de la Suisse. 1–180. *pls. 1–3. fig. 59.* 1908.

('10) ——— Nouvelles Contributions à la Flore Cryptogamique Suisse. Bul. Soc. Bot. Genève ser. 2, 2: 78–81. *figs. 1–4.* 1910.

His method of isolation and the principal media used in the same were as follows:

> The media used for isolation work consisted either of wort-gelatin in tubes or in Erlenmeyer flasks, or of moist bread. The moist bread proved the more advantageous. In preparation of the latter medium the bread was placed in the petri dishes and only sufficient water was added to allow the bread to remain solid after sterilization at 120° C. Before sterilization the dishes were wrapped in blotting paper and were opened only just previous to inoculation. The plates were inoculated with the particular soil (garden and wood soil principally) by means of a flamed match in lieu of the use of a platinum needle. The plates were next carefully wrapped in sterilized paper and preserved in a case for that purpose.

The species isolated by Lendner are: *Absidia Lichtheimi* (Lucet et Costantin) Lendner, *A. spinosa* Lendner, *Mucor adventitius* Oud. var. *aurantiaca* Lendner, *M. genevensis* Lendner, *M. botryoides* Lendner, *M. lamprosporus* Lendner, *M. griseo-cyanus* Hagem, *M. Jansseni* Lendner, *M. dimorphosporus* Lendner.

Namyslowski ('10) needs mention only so far as to state that he has isolated *Zygorrhynchus Vuilleminii* Namy., *Mucor microsporus* Namy., and *Rhizopus arrhizus* Fischer from the soil. In the literature consulted, nothing is stated as to the method of isolation from the soil samples.

In this country Professors Selby and Manns ('09) have devised a method that can be used to advantage in a study of the soil flora, especially when the fungi are in a sporulating stage. While the specific success that has attended this method is not given, still we are led to believe that it has been used to advantage. To quote from the bulletin: "Washings from the soil in which diseased plants occur or washings of samples of seed grain can be placed in the centrifuge (physicians' centrifuge) and there subjected to the rotation and consequent centrifugal effects." In order to be of any value in soil work, it goes without saying that platings must be made from the washings.

Rivas ('10), as the two previous workers, needs mention not because of the fungi he has isolated but because of the method used in collecting his soil samples. It is true that he has isolated ten cultures of molds in connection with thirty cultures of bacteria, but, since no descriptions are given, his work on fungi has no taxonomic value; that is, it does not advance our knowledge of soil forms. His method is given in the following citation:

> The soil was collected in clean test tubes, previously sterilized by dry heat at 200° C. for fifteen minutes or more until a slight browning of the cotton plug took place

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('09) Selby, A. D., and Manns, Thos. F. Studies in Diseases of Cereals and Grasses. Ohio Agr. Expt. Sta. Bul. 203: 191. 1909.

('10) Namyslowski, B. Studien über Mucorineen. Bul. Acad. Sci. Cracovie, Class. Math. et Nat. ser. B. June 1910: 477–520. *pl. 19.* 1910.

('10) ——— Zygorrhynchus Vuilleminii une Nouvelle Mucorinée Isolée du Sol et Cultivée. Ann. Myc. 8: 152–155. *fig. 9.* 1910.

('10) Rivas, D. Bacteria and other Fungi in Relation to the Soil. Contrib. Bot. Lab. Univ. Penn. No. 3, 3: 243–274. 1910.

> (indication of decomposition of organic matter, hence complete sterilization). In like manner all the glassware (test tubes, pipettes, flasks, etc.) was sterilized.
>
> At the time of collecting the samples, after removing the leaf mould layer, the cotton plug was removed from the test tube which was immediately inserted vertically in the ground with a gentle rotary motion to a depth of about 3 to 5 cm. This test tube was withdrawn and the cotton plug immediately replaced. In this manner the uppermost part of the soil, which contains the greatest number of bacteria, was obtained. In cases where it was desirable to collect the samples from the deeper portions of the soil, a vertical cut was made and, after scraping the surface with a sterilized spatula, the sample was collected as above indicated, except that the test tube was inserted horizontally at the desired depth 10 to 12 cm. below the surface.
>
> For the study of the moulds, the samples were taken from that part of the leaf mould layer next to the soil after the top leaves were carefully removed. The material was collected in sterile test tubes and inoculated on nutrient agar plates by touching and gently rubbing the material on the surface of the medium. The plates were incubated at 37° C. and at room temperature for some days, after which a luxuriant growth was obtained. This collection was made during autumn, when the growth of moulds on the ground was found to be more luxuriant.

Beckwith ('11), in North Dakota, found representatives of the following genera to be present in what he terms "wheat-sick soil": Fusarium, two species; Colletotrichum, two species; Macrosporium, Alternaria, Spicaria, Verticillium, Rhopalomyces, Cephalothecium, and Helminthosporium. It would be highly interesting to know whether the same results would follow provided isolations were made in late summer, autumn, and winter, presuming, however, that the above results followed isolations made in May, June, and July. While some of the above fungi have been found repeatedly in the soil, this is the first report of the isolation of others. Without questioning the results, it seems peculiar, however, that no Penicillia nor Mucors should have been encountered, as species of these two genera have been quite generally isolated from the earliest investigations to the present.

In describing his method of isolation and the kind of media used, citation is made from the original:

> A soil solution was made by mixing one part of soil with ten parts of distilled water. This mixture was agitated frequently for twenty-four hours, in order that such readily soluble matter as was present in the soil might go into solution. This solution was then filtered through Pasteur bougies in order to clarify it, and then, without further treatment, was made into a solid medium by the addition of one and one half per cent of agar-agar. The reaction of this medium was very slightly acid, being .02 per cent normal.
>
> Soil samples were collected from a depth of two inches below the surface, using proper precautions to guard against contamination, and a suspension made by adding one gram of the sample to 10 cc. of sterile distilled water. After two minutes agitation in order to obtain as even a mixture of the soil particles and water as possible, this suspension was plated out on the soil agar. Plates were incubated four days at 29°–30° C. After growth had taken place, the cultures were purified.

We may well close this historical discussion by taking into consideration the second method mentioned in the introduction for the determination

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('11) Beckwith, T. D. Root and Culm Infections of Wheat by Soil Fungi in North Dakota. Phytopathology 1: 170–176. 1911.

of the presence of facultative parasites in the soil: that of growing the crop under control experimentation and, provided disease arises, of isolating the organism from the host in case it is of parasitic nature. Saprophytes may likewise be isolated from the debris of plants after death has occurred.

While a number of organisms causing disease in certain crops are generally recognized as living in the soil as saprophytes, at least for some years, still we are rather prone to say such is the case without any too much evidence. It cannot be emphasized too strongly that more work of the nature of Busse, Peters, and Ulrich ('11), connected with the demonstration of the cause of the "Wurzelbrand" of the sugar beet and the presence or absence of the causal organisms in the soil, should be undertaken. A brief discussion of the history of investigations on this subject is as follows: Busse and Ulrich ('08) demonstrated that beet seed-balls were attacked by *Phoma Betae* Fr., while the two other fungi known to produce "Wurzelbrand"— *Pythium de Baryanum* Hesse and *Aphanomyces laevis* de Bary — could not be demonstrated in any case as occurring on the seed-balls. The conclusion of their work is that the diseases produced by the two latter-mentioned fungi do not take their starting point from the seed.

Krüger ('93) came to the conclusion, as a result of his investigations, that infection of beets can come from the soil. Perhaps this is not conclusive, as his communications are too general.

Hiltner and Peters ('05) disinfected the seed-balls after the Hiltner sulfuric acid method (l. c. 220). In all three soils investigated (which were obtained from different sources and were of different natures), the authors found that when sterilized soil, as well as sterilized seed-balls, was used, some disease arose. These results must undoubtedly be attributed to improper sterilization, and, according to the evidence of the following citation, the seed-balls could not have been sterilized.

Busse, Peters, and Ulrich ('11) found that on complete sterilization of soil and seed-balls no "Wurzelbrand" could be produced. When completely sterilized seed-balls but unsterilized soil were used, "Wurzelbrand"

('93) Krüger, F. Phoma Betae Fr. als einer der Erreger von Wurzelbrand der Rübenpflanzen. Zeitsch. Ver. Rübenzuckerind. 43: —. 1893; cited in Arb. Kais. Biol. Anst. Land-. und Forstw. 6: 261. 1908.

('05) Hiltner, L., and Peters, L. Untersuchungen über die Keimlingskrankheiten der Zucker-. und Runkelrüben. Arb. Kais. Biol. Anst. Land-. und Forstw. 5: 207–253. 1905.

('08) Busse, W., and Ulrich, P. Über das Vorkommen von Wurzelbranderregern auf der Rübensaat. Arb. Kais. Biol. Anst. Land-. und Forstw. 6: 373–384. 1908.

('11) Busse, W., Peters, L., and Ulrich, P. Über das Vorkommen von Wurzelbranderregern im Baden. Arb. Kais. Biol. Anst. Land-. und Forstw. 8: 260–302. 1911.

of the nature produced by *Pythium de Baryanum* Hesse and *Aphanomyces laevis* de Bary occurred in soil that contained these organisms. (These organisms are not in all soils, which is to be expected; still they are quite generally distributed in Germany.) With the use of completely sterilized soil and unsterilized seed-balls, " Wurzelbrand " produced by *Phoma Betae* Fr. occurred. The authors conclude that *Phoma Betae* Fr. does not live from season to season in the soil, but that it is carried over on the seed-balls; on the other hand, *Pythium de Baryanum* Hesse and *Aphanomyces laevis* de Bary live as saprophytes in the soil, and under suitable conditions they can attack the beet. In passing it should be stated that the number of soils tested was more than sufficient to warrant the conclusions. Some of the soils had not been in beets since 1899; some since 1902, 1903, and 1904; others had been in beets in 1908, when this work was completed.

That *Phoma Betae* Fr. can be carried over winter in the soil is supported by Frank ('95). From the nature of his investigations and the evidence against his view, we may conclude that his point is not well taken.

From the above data, it must be accepted that *Pythium de Baryanum* Hesse and *Aphanomyces laevis* de Bary constitute a part of the soil flora; and that *Phoma Betae* Fr. has not as yet been proved to live in the soil.

Manns ('11) has worked with *Fusarium oxysporum* Schlecht. (*Fusarium orthoceras* Appel), causing the dry rot of potatoes. The evidence to the effect that this fungus may live in the soil is similar to that just given with respect to *Pythium de Baryanum* Hesse and *Aphanomyces laevis* de Bary.

Finally, it should be stated that there are many plant pathologists who have given rather convincing circumstantial evidence to allow the acceptance that certain facultative parasites, as *Fusarium vasinfectum* Atk., *Pythiacystis citrophthora* R. E. & E. Smith, *Oospora scabies* Thaxter, *Thielavia basicola* (B. & Br.) Zopf, and others, can live as pure saprophytes in the soil for a period of several years. However, space will not allow of a presentation of this evidence.

PRESENT INVESTIGATIONS

Soils examined

The writer's investigations were restricted to a study of the fungi in arable soil. The original plan was to take a soil sample every month of the year from the same field. This plan was later partially abandoned.

('95) Frank, A. B. Neue Untersuchungen über Phoma Betae. Zeitsch. Ver. Rübenzuckerind. D. R. 45: 180 and 272. 1895.

('11) Manns, T. F. The Fusarium Blight and Dry Rot of the Potato. Ohio Agr. Expt. Sta. Bul. 229: 316–317. 1911.

The first three samples, A, B, C, were taken in July, August, and September from an oats field near the Agricultural College at Ithaca. When the first sample was taken, the oats were nearly ripe. When the second was taken, the oats had been harvested. This field was considered worn out in the early seventies; since that time it has grown a crop every year. The rotation practiced has been wheat, corn, and oats; the last-named crop was grown in 1910. The field has received no coating of manure since 1874. The soil is a Dunkirk clay loam.

The sample for D isolation (October) was taken from a barrel of soil shipped from East Hampton, Long Island. The soil was a sandy loam and in 1910 had grown a crop of potatoes. The harvest had been small; probably a conservative estimate would be fifty per cent of the normal. The prevalent diseases were those caused by *Oospora scabies* Thaxter, *Corticium vagum* B. & C. var. *Solani* Burt, and *Fusarium oxysporum* Schlecht. Further history pertaining to this soil was not obtained, except the fact that the field has been under cultivation for many years.

Samples E, F, G, H, and I (November, December, 1910; January, February, and March, 1911) were taken from the plant-breeding experimental garden east of the college. The land has borne crops constantly since the early seventies and probably has been under cultivation for the major part of one hundred years. The soil in that part of the garden where the samples were taken is a Genesee silt loam. The crop grown in 1910 was peppers.

Samples J, K, L, M, N, and O (May to September, 1911) were taken from a potato field near Atlanta, N. Y. The soil is probably a Volusia gravelly sandy loam. The field has been under cultivation constantly for many years. Among the crops grown have been potatoes, clover, and oats. The crop in 1911 was potatoes.

Toward the latter part of the summer, samples were taken both from a part of a field to which sulfur had been applied and from a part that had been left untreated serving as a check in some other experimental work. The purpose of making isolations from these samples was to find out if sulfur, three months after application, had changed in any way the fungous flora of the soil. The results proved to be negative.

Methods of taking soil samples

Samples A, B, C, D, and E were obtained after the same manner. The instrument for taking the samples consisted of an iron tube, one inch in diameter and about eight inches long, threaded at both ends. The threads on the one end served for fastening the tube to a rod (used as a handle similar to that of a soil auger) by a reducing coupling. This end of the tube was plugged with cotton. The threads on the other end served for receiving a threaded cap that was made to fit very snugly. The tube, being closed by means of the cotton plug and the cap, was sterilized in a hot air sterilizer for one hour at 140° C. The tube was attached to the handle on arriving in the field, and after the very topmost layer of soil (approximately one fourth inch deep) had been removed, the cap was removed and the tube inserted into the soil by a rotary motion. The soil being under cultivation, the tube could be inserted to a depth of about six or seven inches without much difficulty. The tube was now extracted from the soil and the cap again attached. The main objection to taking the sample by this method lies in the resistance offered by the tube to the entrance of the soil. When the tube is inserted into the soil seven inches, the soil to this depth is not sampled owing to compression.

In December, 1910, the soil had become frozen so that samples could not be taken by using the above-mentioned tube. The following method was therefore resorted to during December, January, February, and March: A pit approximately ten inches wide, two feet long, and one foot deep was dug. With a sterile knife (flamed over an alcohol lamp) the soil was removed from the edge of the pit, where it was desired to obtain the samples. After removal of this soil, the knife was again sterilized and the sample was taken at the desired depth, one to three inches, and removed as quickly as possible to a sterile wide-mouthed glass bottle, after removal of the cotton plug. Immediately following the introduction of the soil into the bottle, the cotton plug was again replaced. A second sample was taken directly below the first at a depth of four to five inches, and again a third at a depth of six to eight inches. Precautions were always observed to avoid as much as possible any contamination.

In May, 1911, laboratory equipment as complete as possible was shipped to Atlanta, N. Y., where the summer's field work was to be carried out. Having only a modified Arnold sterilizer at command, the method of taking samples necessarily had to be altered.

Samples J, K, L, M, and N were taken after the following manner: Three Erlenmeyer flasks, each containing 50 cc. of distilled water and carefully plugged with cotton, were sterilized in the modified Arnold sterilizer for thirty minutes at 97° to 99° C. on three consecutive days. After sterilization they were taken into the potato field where the samples were to be collected. A pit was dug similar to that described above in the winter collection of samples. At each of the depths two, four, and six inches, a small quantity of the soil (approximately one fifth gram) was taken on the end of a sterile scalpel (flamed in an alcohol lamp) and introduced into each of the Erlenmeyer flasks. Every precaution was observed to avoid contamination, as previously mentioned. The flasks containing the inoculated water were now taken to the laboratory, where they were vigorously shaken at intervals during two to four hours in order to break up the soil lumps and liberate any enclosed fungus spores.

Toward the end of the summer of 1911, another method for the isolation of fungi, which can be used apparently to considerable advantage, was perfected. The writer had opportunity to take but one sample to test this method; in this case, however, it yielded very satisfactory results. The method is as follows: A lamp chimney of sufficiently small size to allow the passage of the top through the mouth of a pint or quart fruit jar, when the chimney is inverted, was used as a retainer of the sample. To serve as a support for the soil, four thicknesses of cheesecloth were fastened over the top of the chimney. The base of the chimney was plugged with absorbent cotton. After inversion, the top of the chimney was passed through the mouth of the jar and the chimney placed in position. Absorbent cotton was wrapped about the mouth of the jar and the chimney (Fig. 100). The apparatus was now sterilized. As already stated, fractional sterilization in a modified Arnold was resorted to.

After sterilization the jars were taken into the field and the soil was introduced into the chimneys after the removal of the cotton plugs. When the samples had been thus disposed of, the plugs were again inserted and the apparatus containing the soil removed to the laboratory.

On arriving at the laboratory, the soil in the chimneys was moistened with sterile water, care being taken to use only sufficient water to initiate percolation. The apparatus was now set aside until various fungi could be seen in fruiting condition on the cheesecloth. This was readily observed because of the use of the glass jar. The chimneys were now removed and poured plates were made of the fungi in order to obtain pure cultures. A study was made of the fungi in their fruiting condition on the cheesecloth for comparison with those produced in culture.

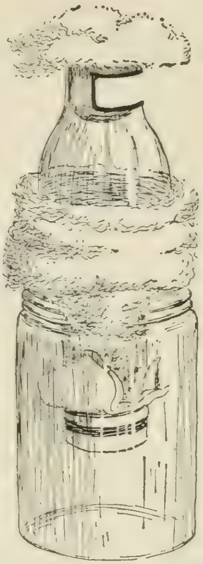

Fig. 100.—*Culture chamber devised for the isolation of soil fungi*

Sterilization of glassware

All petri dishes were double-wrapped in manila paper and sterilized for two hours at 140° C. All other glassware, including test tubes, pipettes, bottles, flasks, etc., was sterilized in the hot air sterilizer (except when otherwise stated) for one hour at 140° C.

Preparation and sterilization of media

The media used were soil extract agar, nutrient agar, manure extract agar, potato decoction agar, moist bread, gelatin, Uschinsky's solution, Raulin's culture fluid, Cohn's nutrient solution, lactic acid solution, lactose solution, potato plugs, and wheat stem plugs. The preparation and formula of each follows:

Soil extract agar I.— Prepared according to the following formula:

Distilled water	800 cc.
Soil extract[1]	200 cc.
Dextrose	10 gms.
Dipotassium phosphate (K_2HPO_4)	.5 gm.
Magnesium sulfate ($MgSO_4$)	.2 gm.
Agar	15 gms.

After washing, the agar was always melted over a free flame and stirred constantly in order to prevent burning. It was next added to the above solution and cooked in a double boiler for one hour, then titrated, filtered, and sterilized in the autoclave.

Soil extract agar II.— Prepared according to the formula given under soil extract agar I. The extract was prepared as follows: The soil that served as a basis for this extract was a gravelly sandy loam. It was taken from land seeded to grass and contained many small roots. The moisture content was first determined and was found to be approximately 15.6 per cent. To obtain approximately 3,000 grams of dry soil, 3,555 grams of the wet soil was used. To this soil was added 625 cc. of hydrochloric acid (125 cc. HCl sp. gr. 1.1328, and 500 cc. distilled water). Digestion was allowed to proceed at room temperature for twenty-four hours. The soil was next placed over a warm radiator and allowed to dry for two days. To the soil was then added 1,000 cc. of ammonia water solution (400 cc. ammonia sp. gr. .96, and 600 cc. of distilled water). The soil was allowed to stand at room temperature for twenty-four hours, and then kept over a warm radiator for five days with repeated stirring. No ammoniacal odor could be detected at the end of the period, and the soil felt dry to the touch. Water sufficient to make four liters of filtrate was added. The filtrate constituted the soil extract used during the winter of 1910-1911 and the spring and summer of 1911.

As already stated, this agar was made up identically as was soil extract agar I. It was always titrated and found invariably to be acid. It has been used without any further modifications. Of all the media used, this is superior without question for the isolation of soil fungi and has been the standard medium. While it shows superiority in isolation work, still it seems to produce abnormal growth and for this reason the detailed study of species has been made on other media, nutrient agar and wheat plugs.

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[1] The writer is indebted to Dr. H. J. Conn, a graduate student in the Department of Soil Technology, College of Agriculture, Cornell University, at the time this investigation was begun, for the soil extract used as a basis of the agar for isolations A, B, and C, and for suggestions as to making this extract as well as the medium. His work on soil bacteria had led him to conclude that this medium might well be adapted for fungus isolation. While the details of obtaining this extract cannot be given, it does not differ particularly from that described under soil extract agar II.

Soil extract agar III.— One and one half kilograms of sandy soil were mixed with three liters of water and allowed to stand at room temperature over night (approximately seventeen hours). It was extracted for two hours in the autoclave at 20 pounds pressure. The filtrate obtained was used in the following formula:

Distilled water	800 cc.
Soil extract	200 cc.
Dextrose	10 gms.
Dipotassium phosphate (K_2HPO_4)	.5 gm.
Magnesium sulfate	.2 gm.
Agar	15 gms.

The medium was prepared as were I and II.

Nutrient agar[1].— Prepared according to the following formula:

Distilled water	1,000 cc.
Glucose	5 gms.
Sodium chlorid	5 gms.
Witte's peptone	5 gms.
Liebig's beef extract	3 gms.
Agar	15 gms.

Manure extract agar.— Prepared as follows: To 100 grams of well-rotted horse manure was added 500 cc. of distilled water. This was allowed to stand for twenty-four hours at room temperature and then filtered. The filtrate was used as a stock solution.

I.	Distilled water	800 cc.
	Manure extract	200 cc.
	Agar	16 gms.
II.	Distilled water	666 cc.
	Manure extract	333 cc.
	Agar	16 gms.

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[1] This was made by first preparing the bouillon. The calculated amount of water was placed in a double boiler, and beef extract, peptone, sodium chlorid, and glucose were added; this was then cooked for one half hour and at the end the water lost by evaporation was restored. The agar was cut into small pieces, tied loosely in clean cheesecloth, and washed in running tap water for twenty minutes. At the end of this period, the agar was removed from the cloth, placed in a stewpan, and covered with bouillon. It was then boiled over a free flame until all the agar was melted. The melted agar was poured into the bouillon, the whole boiled for one half hour, and then cooled to 58° C.; the well-beaten whites of two eggs were added, and the solution was thoroughly mixed. . Cooking in the double boiler was continued for one hour. The water lost by evaporation was restored. Toward the end of the cooking, the solution was titrated to 1.5 +. After cooking, it was filtered and sterilized in the autoclave at 17 to 18 pounds pressure for one half hour.

The agar after washing was added to the solution, after being melted over a free flame, cooked for one hour in a double boiler, filtered, and fractionally sterilized. (This medium was used only during a part of the summer of 1911.)

Potato decoction agar.— Prepared as follows: Two average-sized potatoes were washed, pared, and sliced very thin. To these were added about two times their volume of water. This was now heated for two hours, but never allowed to boil. After cooking, it was filtered through cotton, and 30 grams of agar and 5 grams of glucose were added. The mixture was now cooked in the autoclave for twenty minutes at 17 to 18 pounds pressure. After cooking and distribution to test tubes, it was sterilized in the autoclave for thirty minutes at 17 to 18 pounds pressure.

Moist bread.— Prepared by adding only sufficient water to the bread to allow it to remain solid after sterilization in the autoclave.

Gelatin.— Prepared according to Thom ('10). It consisted of 15 per cent gelatin in water; the whole cooked in a double boiler for thirty minutes, then filtered and fractionally sterilized.

Uschinsky's solution.— Prepared according to the formula as given by Smith ('05). Sterilized in autoclave for twenty minutes.

Distilled water	1,000
Glycerin	30 to 40
Sodium chlorid	5 to 7
Calcium chlorid	.1
Magnesium phosphate	.3 to .4
Dipotassium phosphate	2 to 25
Ammonium lactate	6 to 7
Sodium asparaginate	3 to 4

Raulin's culture fluid.— Prepared according to formula as given by Smith ('05).

Distilled water	1,500.
Granulated cane sugar	70.
Tartaric acid	4.
Ammonium nitrate	4.
Ammonium phosphate	.60
Magnesium carbonate	.40
Ammonium sulfate	.25
Zinc sulfate	.07
Ferrous sulfate	.07
Potassium silicate	.07

('05) Smith, E. F. Bacteria in Relation to Plant Diseases. Carnegie Inst. Washington Pub. 27: 197. 1905.

('10) Thom, Charles. Cultural Studies of Species of Penicillium. U. S. Dept. Agr., Bur. Anim. Indus. Bul. 118: 22. 1910.

Cohn's nutrient solution.— Prepared according to formula given by Smith ('05).

Distilled water	1,000.
Acid potassium phosphate (KH_2PO_4)	5.
Magnesium sulfate	5.
Neutral ammonium tartrate	10.
Potassium chlorid	.5

Lactic acid solution.— Prepared according to the following formula:

Water	1,000.
Lactic acid	9.

Lactose solution.— Prepared according to the following formula:

Water	1,000.
Lactose	30.

All the above liquid media were sterilized in the autoclave for fifteen minutes at 17 to 18 pounds pressure.

Potato plugs.— These were cut and prepared as usually recommended in bacteriological work.

Wheat stem plugs.— Stems of mature wheat were cut into pieces approximately three inches long, and three to five were placed in each test tube. Distilled water was now added to cover the lower third of the plugs, and the whole was sterilized in the autoclave for fifteen minutes at 17 to 18 pounds pressure.

Methods of isolation

Isolations were made from samples A, B, D, and E after the following manner: Plates were poured and the media allowed to cool. While the media were cooling, the tube containing the soil sample was washed externally with mercuric chlorid solution (1–1,000). The cap was taken off, and with a sterile scalpel (sterilized in a gas flame) the soil was removed from the tube to a depth of about one fourth inch. This precludes all possibility of using contaminated soil for inoculation of the plates. The smallest masses of soil that could be taken on the point of a sterile scalpel were taken from the tube and planted in the petri dishes containing the agar. Five such masses were placed at different parts of each dish. Before each planting was made, the scalpel was again flamed. In making the inoculation, the covers of the dishes were raised only sufficiently to allow the introduction of the scalpel and immediately thereafter they were replaced in position. Before inoculating a second dish, the soil was

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('05) Smith, E. F. Bacteria in Relation to Plant Diseases. Carnegie Inst. Washington Pub. 27: 197. 1905.

removed from the tube again for some distance. This method of procedure was followed until ten dishes had been inoculated, when the soil had been quite generally sampled. After inoculation the dishes were set aside at room temperature and the fungi allowed to develop.

Bacteria usually grow well for a short distance about the planting, but in the course of a few days the fungi very readily outgrow them and transfers to other plates can be made. Pure cultures were often obtained in this way, but for absolute certainty dilution plates were always poured after the fungi had fruited in the transfer plates.

In passing it should be stated that whenever isolations were being made, uncovered plates were usually allowed to stand exposed in the culture room in order to determine the possible contaminations arising in the inoculated plates. A fungus was never accepted as being isolated from the soil unless it showed up repeatedly in the plates of the same isolation.

The tube containing sample C was sterilized externally, as already indicated for the above-mentioned cultures. The soil was transferred from the tube to sterile wide-mouthed bottles by means of a sterile spatula. The soil was mixed as thoroughly as possible by stirring it with a sterile glass rod. Approximately 2 grams was transferred to 100 cc. of sterile water in an Erlenmeyer flask. After a thorough shaking, 1 cc. was transferred to 9 cc. of sterile water contained in a test tube. From these 10 cc. a transfer of 1 cc. was made to 9 cc. of water. The resulting 10 cc. was used for pouring ten plates, 1 cc. to a plate, thus making a dilution of 1–5,000.

The soil of samples F, G, and H was brought to the laboratory and allowed to stand in the bottles over a radiator for four hours. In order to obtain an average of the sample it was now placed in a sterile tin soil sieve, such as is used in soil technology. This instrument makes an ideal apparatus for this purpose, as it is provided with a tin cover and receiver that fit snugly over the top and bottom of the sieve. The only possible contamination arises, therefore, in the transfer of the soil. The sieve was always sterilized by passing it through a flame a number of times just prior to using. In sifting the soil, the lid was occasionally partly removed so that a spatula could be introduced to crush some of the larger particles of soil. Considerable difficulty arose in sifting the soil sample taken from the uppermost part of the soil, because of its wetness.

After sifting had been completed, about one gram (dry weight) of soil was taken from the receiver and weighed out in a tared, wrapped, and sterilized watch glass. The soil was now transferred to 100 cc. of sterile water in an Erlenmeyer flask and thoroughly shaken. As quickly as possible, and during some agitation of the flask, 1 cc. was taken and then transferred to 9 cc. of sterile water in a test tube. This 10 cc. (dilution

1-1,000) was used for pouring ten plates. In other cases further dilution (1-10,000) was made before pouring the plates. Prior to pouring some of the plates, a few drops of potassium hydroxid (KOH) were added to the melted medium in the test tubes to make it alkaline.

As a check on the isolations F, G, and H, isolation I was made. The roots of a pepper and a corn plant left over in the soil from 1910 were carefully removed from the soil and taken immediately to the laboratory, where the soil was washed from them. Roots from each plant were immersed in mercuric chlorid solution (1-1,000), where they were kept for two minutes. Following this, they were transferred to sterile water. Parts of these roots showing discolored areas were transferred with a sterilized scalpel to plates containing agar. The results, in general, were what was expected, that is, the same saprophytes that were isolated from the soil were isolated from the roots. (For details note results of isolations F, G, H, and I.)

Isolations J, K, L, M, and N were made after the same method, which is as follows: From the flasks containing the inoculated water, about 1 cc. of the solution was poured into a petri dish. Into a second and a third dish a few drops of sterile water were poured. By means of a platinum loop, dilutions from plate I were made by transferring a few loopfuls of the inoculated water to the sterile water in plates II and III. To the plates was now added the melted agar cooled to about 40° C. (tested by applying the test tube to the skin just below the eye).

From the soil sample designated O the fungi grew out and fruited on the cheesecloth, as previously mentioned. To isolate these organisms and obtain pure cultures, dilution plates were poured.

Results of isolations

Other forms than those here indicated appeared in the petri dishes. Many forms never fruited; others were lost in pouring dilution plates for pure cultures where some of the rapidly growing fungi crowded out those growing more slowly. A number of apparently different Fusaria were encountered, but classification was not attempted. Three of these Fusaria were used in one series of inoculations of potato tubers; two gave positive results, while one was negative. Time has not permitted further confirmation of these results, so it cannot be stated positively that *Fusarium oxysporum* Schlecht. was isolated from the soil by cultural methods, although the morphology of the Fusaria isolated does not differ materially from the dry rot organism of the potato.

Forms isolated from the different samples.—

A. July 14, 1910. *Chaetomium olivaceum* Cooke & Ellis, Fusaria, *Mucor circinelloides* van Tiegh., *Mucor hiemalis* Wehm., *Mycogone nigra*

(Morgan) emend., *Penicillium expansum* (Link) Thom, *Penicillium chrysogenum* Thom, *Penicillium desciscens* Oud., *Hormodendrum Hordei* Bruhne, *Pleurage verruculosis* n. sp., *Sporormia fasciculata* n. sp., *Sachsia albicans* C. Bay, *Trichoderma lignorum* (Tode) Harz, a pycnidial form that was not determined, red yeast.

B. August 20, 1910. Fusaria, *Hormodendrum cladosporioides* (Fres.) Sacc., *Mycogone nigra* (Morgan), *Penicillium desciscens* Oud., *Penicillium expansum* (Link) Thom, *Pleurage verruculosis* n. sp., Torula not determined, *Trichoderma lignorum* (Tode) Harz.

C. September 9, 1910. *Alternaria fasciculata* Cooke & Ellis, *Aspergillus Koningi* Oud., *Hormodendrum cladosporioides* (Fres.) Sacc., *Penicillium chrysogenum* Thom, *Penicillium expansum* (Link) Thom, *Trichoderma Koningi* Oud., *Trichoderma lignorum* (Tode) Harz.

D. October 8, 1910. *Hormodendrum cladosporioides* (Fres.) Sacc., *Mucor racemosus* Fres., *Penicillium expansum* (Link) Thom, *Trichoderma lignorum* (Tode) Harz, *Zygorrhynchus Vuilleminii* Namy., *Zygorrhynchus Moelleri* Vuill., *Rhizopus nigricans* Ehren.

E. November 17, 1910. *Aspergillus Koningi* Oud., *Aspergillus fumigatus* Fres., Fusaria, *Hormodendrum cladosporioides* (Fres.) Sacc., *Mucor botryoides* Lendner var. *minor* n. var. (isolated also from garden soil), *Mucor hiemalis* Wehm., *Rhizopus nigricans* Ehren. var. *minor* n. var., *Mucor plumbeus* Bonord., *Penicillium expansum* (Link) Thom, *Penicillium terrestre* n. sp., *Spicaria simplicissima* Oud., *Trichoderma lignorum* (Tode) Harz.

F. December 12, 1910. *Alternaria fasciculata* Cooke & Ellis, *Aspergillus fumigatus* Fres., *Aspergillus Koningi* Oud., Fusarium, *Hormodendrum cladosporiodes* (Fres.) Sacc., *Mucor racemosus* Fres., *Mucor circinelloides* van Tiegh., *Mucor hiemalis* Wehm., *Mycogone nigra* (Morgan), *Penicillium humicola* Oud., *Penicillium expansum* (Link) Thom, *Rhizopus nigricans* Ehren., *Rhizopus nigricans* Ehren. var. *minor* n. var., *Trichoderma lignorum* (Tode) Harz.

G. January 7, 1911. *Aspergillus Koningi* Oud., *Trichothecium roseum* Link, *Penicillium expansum* (Link) Thom, *Spicaria simplicissima* Oud., *Trichoderma Koningi* Oud., red yeast.

H. March 10, 1911. *Alternaria fasciculata* Cooke & Ellis, *Acrostalagmus albus* Preuss. var *varius* n. var., Fusarium, *Hormodendrum cladosporioides* (Fres.) Sacc., *Mucor mucedo* (Linné) Bref., *Mucor racemosus* Fres., *Penicillium expansum* (Link) Thom, *Trichoderma Koningi* Oud.

I. March 17, 1911. *Aspergillus globosus* n. sp., *Mucor circinelloides* van Tiegh., *Mucor botryoides* Lendner var. *minor* n. var., *Mucor mucedo* (Linné) Bref., *Mucor racemosus* Fres., *Penicillium expansum* (Link) Thom, *Spicaria simplicissima* Oud., *Thamnidium elegans* Link.

J. May 15, 1911. *Botrytis terrestris* n. sp., Fusarium, *Hormodendrum Hordei* Bruhne, *Mycogone nigra* (Morgan), *Penicillium expansum* (Link) Thom.

K. June 15, 1911. Fusarium, *Penicillium expansum* (Link) Thom, *Penicillium terrestre* n. sp.

L. July 13, 1911. *Hormodendrum cladosporioides* (Fres.) Sacc., *Penicillium expansum* (Link) Thom, *Trichoderma Koningi* Oud., *Zygorrhynchus Vuilleminii* Namy.

M. August 15, 1911. *Aspergillus fumigatus* Fres., *Botrytis terrestris* n. sp., *Hormodendrum cladosporioides* (Fres.) Sacc., *Penicillium expansum* (Link) Thom, *Zygorrhynchus Vuilleminii* Namy.

N. September 8, 1911. *Chaetomium olivaceum* Cooke & Ellis, Fusarium, *Hormodendrum cladosporioides* (Fres.) Sacc., *Hormodendrum Hordei* Bruhne.

O. *Chaetomium olivaceum* Cooke & Ellis, Monilia not determined, *Penicillium expansum* (Link) Thom, *Stachybotrys cylindrospora* n. sp., *Stachybotrys atra* Cda.

Summary of species isolated from all samples.— *Acrostalagmus albus* Preuss. var *varius* n. var., *Alternaria fasciculata* Cooke & Ellis, *Aspergillus fumigatus* Fres., *Aspergillus globosus* n. sp., *Aspergillus Koningi* Oud., *Botrytis terrestris* n. sp., *Chaetomium olivaceum* Cooke & Ellis, *Hormodendrum cladosporioides* (Fres.) Sacc., *Hormodendrum Hordei* Bruhne, *Mucor botryoides* Lendner var. *minor* n. var., *Mucor circinelloides* van Tiegh., *Mucor hiemalis* Wehm., *Mucor mucedo* (Linné) Bref., *Mucor plumbeus* Bonord., *Mucor racemosus* Fres., *Mycogone nigra* (Morgan), *Penicillium chrysogenum* Thom, *Penicillium desciscens* Oud., *Penicillium expansum* (Link) Thom, *Penicillium humicola* Oud., *Penicillium terrestre* n. sp., *Pleurage verruculosis* n. sp., *Rhizopus nigricans* Ehren., *Rhizopus nigricans* Ehren. var. *minor* n. var., *Sachsia albicans* C. Bay, *Spicaria simplicissima* Oud., *Sporormia fasciculata* n. sp., *Stachybotrys atra* Cda., *Stachybotrys cylindrospora* n. sp., *Thamnidium elegans* Link, *Trichoderma Koningi* Oud., *Trichoderma lignorum* (Tode) Harz, *Trichothecium roseum* Link, *Zygorrhynchus Moelleri* Vuill., *Zygorrhynchus Vuilleminii* Namy.

TAXONOMIC CONSIDERATION OF ALL FORMS RECORDED FROM SOIL

In a consideration of the species of soil fungi, it has seemed advisable to classify them under two heads: the facultative parasites and the obligate saprophytes.

While facultative parasites are generally accepted as living in the soil, much of the evidence to support this view is circumstantial. The specific descriptions of the members of this group of organisms have not been given. This has not seemed desirable because of the great amount of valuable literature so readily available pertaining to each species. and the difficulty that arises in giving a good tenable description of some species in the space allotted. On the whole it is perhaps preferable to allow the reader to consult the originals, and for this reason the references are inserted.

In a consideration of the obligate saprophytes, it has been the attempt of the writer to make a monograph of all those species that have been thus far isolated from or found growing in the soil. To what extent this has been successful, the future must tell. Probably there are a number of species that have escaped attention. The *nomina nuda* species recorded have been purposely omitted.

The writer purports to present but very little that is new. He has isolated some species that have not heretofore been isolated from the soil but have nevertheless been described. A few species and varieties appear to be new to science. All the figures are original and represent only those species that the writer has isolated.

No key to the determination of all the species has been given because of the little value that it would serve; however, it is hoped that the key to the Mucorales may be of considerable use. This key is practically taken from Lendner's "Les Mucorinées de la Suisse." The only alteration has been in the way of additions to fit the few new species not provided for in that monograph.

Facultative parasites

Olpidium Brassicae Woron. Produces a damping off of cabbage seedlings.

Woronin, Michael. Plasmodiophora Brassicae, Urheber der Kohlpflanzenherni. Pringsh. Jahrb. **11**: 556–561. *pls. 31–32.* 1878.

Olpidium Nicotianae Preiss. At first designated by the author as a new species, now considered by him only a variety of *O. Brassicae.* The parasite, besides attacking tobacco seedlings, is also parasitic on cabbage seedlings, on the roots of *Chenopodium album* and *Portulaca oleracea.*

Preissecker, K. Ein kleiner Beitrag zur Kenntniss des Tabakbaues im Imoskaner Tabakbaugebiet. Tach. Mitt. d. k. k. österr. Tabakregie Heft I, Wien. 1905.

Chrysophlyctis endobiotica Schilb. Produces the wart disease of the potato.

Güssow, H. T. A Serious Potato Disease Occurring in Newfoundland. Dept. Agr., Central Expt. Farm, Ottawa, Canada. Bul. 63. 1909.

Orton, W. A., and Field, Ethel C. Wart Disease of the Potato. U. S. Dept. Agr., Bur. Plant Indus. Circ. 52: 1–11. 1910.

Potter, M. C. A New Potato Disease. Jour. Bd. Agr. Great Britain **9**: 320. 1902.

Schilbersky, K. Ein neuer Schorfparasit der Kartoffelknollen. Ber. Deut. Bot. Gesell. **14**: 36–38. 1896.

Asterocystis radicis De Wild. Attacks flax, producing the so-called "Flacksbrand" in Flanders.

Marchal, E. Recherches Biologiques sur une Chytridinée parasite du Lin. Rev. Myc. **23**: 113–117. 1901.

Urophlyctis leproides (Trabut) Magn. Occurs on root outgrowths of the beet, *Beta vulgaris*.

Magnus, P. On some species of the genus Urophlyctis. Ann. Bot. **11**: 87–96. *pls. 7-8.* 1897.

——— Über eine neue unterirdisch lebende Art der Gattung Urophlyctis. Ber. Deut. Bot. Gesell. **19**: 145–153. *pl. 27.* 1901.

Urophlyctis Rubsaameni Magn. Produces swellings on the roots of *Rumex scutatus* L.

Magnus, P., l. c. 1901.

Urophlyctis Alfalfae (Lagerh.) Magn. Produces swellings on the top and chief side roots of *Medicago sativa* L.

Magnus, P., l. c. 1901.

——— Über die in den knolligen Wurzelauswüchsen der Luzerne lebende Urophlyctis. Ber. Deut. Bot. Gesell. **20**: 291–296. *pl. 15.* 1902.

Aphanomyces laevis de Bary. Causes "Wurzelbrand" of the beet.

de Bary, Anton. Einige neue Saprolegnieen. Pringsh. Jahrb. **2**: 179. *figs. 17–18.* 1860.

Humphrey, J. E. The Saprolegniaceae of the United States, with Notes on other Species. Trans. Amer. Phil. Soc. Philadelphia **17**: 128–129. 1892.

Kasanowsky, V. Aphanomyces laevis de Bary. I. Entwicklung der Sexualorgane und Befruchtung. Ber. Deut. Bot. Gesell. **29**: 210–228. *pl. 1.* 1911.

Peters, L. Über die Erreger des Wurzelbrandes. Arb. Kais. Biol. Anst. Land-. und Forstw. **8**: 239–246. *fig. 10.* 1911.

Pythium de Baryanum Hesse. Causes damping off of a variety of seedlings.

Atkinson, G. F. The Potting Bed Fungus. New York (Cornell) Agr. Expt. Sta. Bul. 94: 234–247. *pl. 1.* 1894.

Butler, E. J. An Account of the Genus Pythium and some Chytridiaceae. Mem. Dept. Agr. India, Bot. Ser. No. 5, **1**: 86–91. 1907.

Hesse, R. Pythium de Baryanum, ein Endophytischer Schmarotzer. Halle. 1874.

Miyake, K. The Fertilization of Pythium de Baryanum. Ann. Bot. **15**: 653–667. *pl. 36.* 1901.

Ward, H. Marshall. Observations on the Genus Pythium (Pringsh.). Quart. Jour. Mic. Sci. **23**: 485–519. *pls. 34–36.* 1883.

Pythiacystis citrophthora R. E. & E. Smith. Causes the brown rot of the lemon.

Smith, R. E., and Smith, Elizabeth. A New Fungus of Economic Importance. Bot. Gaz. **42**: 215–221. *figs. 1–3.* 1906.

Smith, R. E. The Brown Rot of the Lemon. California Agr. Expt. Sta. Bul. 190: 1–70. *figs. 1–29.* 1907.

Sclerotinia libertiana Fuckel. Causes the lettuce drop.

Humphrey, J. E. Diseases of the Cucumber Plant. A Sclerotium Disease. Massachusetts Agr. Expt. Sta. Rpt. **10**: 212–224. *pls. 1–2.* 1892.

Smith, R. E. Botrytis and Sclerotinia: Their Relation to Certain Plant Diseases and to Each Other. Bot. Gaz. **29**: 369–407. *pls. 25–27. figs. 1–3.* 1900.

Stevens, F. L. A Serious Lettuce Disease. North Carolina Agr. Expt. Sta. Bul. 217: 1–21. 1911.

——— A Serious Lettuce Disease and Method of Control. North Carolina Agr. Expt. Sta. Tech. Bul. 8: 85–145. *figs. 1–31.* 1911.

Stone, G. E., and Smith, R. E. "Drop" of Lettuce. Massachusetts (Hatch) Agr. Expt. Sta. Rpt. **9**: 79–81. 1897. (Compare also **10**: 55–58. 1898; and **11**: 149–151. 1899.)

Corticium vagum B. & C. var. *Solani* Burt. A root and stem rot fungus attacking potatoes, beans, cotton, etc.

Appel, O., and Wollenweber, H. W. Grundlagen einer Monographie der Gattung Fusarium (Link). Arb. Kais. Biol. Anst. Land-. und Forstw. **8**: 141–156. *pl. 1, figs. 60–64; pl. 3, fig. 2.* 1910.

Atkinson, Geo. F. Some Diseases of Cotton. Alabama Agr. Expt. Sta. Bul. 41: 30–39. 1892.

Clinton, G. P. Rhizoctonia (Rosette). Connecticut Agr. Expt. Sta. Rpt. **28**: 325–326. *pl. 26, figs. a-c.* 1904.

Duggar, B. M., and Stewart, F. C. The Sterile Fungus Rhizoctonia. New York (Cornell) Agr. Expt. Sta. Bul. 186: 50–76. *figs. 15–23.* 1901. Ibid. New York (Geneva) Agr. Expt. Sta. Bul. 186: 4–30. *figs. 15–23.* 1901.

Pammel, L. H. Preliminary Notes on a Root-Rot Disease of Sugar Beets. Iowa Agr. Expt. Sta. Bul. 15: 243–251. *pls. 3–4.* 1891.

Rolfs, F. M. Potato Failures (Two Reports). Colorado Agr. Expt. Sta. Bul. 70: 1–20. 1902. Bul. 91: 1–33. 1904.

Rhizoctonia Medicaginis DC. Produces root disease of alfalfa.

De Candolle, A. P. Mémoire sur les Rhizoctones nouveau genre de Champignons qui attaquent les Racines des Plantes, et en particulier celle de la Luzerne cultivée. Mém. Muséum Paris **2**: 209. 1815.

Duggar, B. M. *Rhizoctonia Medicaginis* DC. Fungous Diseases of Plants, 477–479. *fig. 239.* 1909.

Frank, A. B. Krankheiten der Pflanzen **2**: 514–518. 1896.

Heald, F. D. *Rhizoctonia Medicaginis* in America. Phytopathology **1**: 105. 1911.

Kuhn, J. Die Krankheiten der Kulturgewächse, 245. 1858.

Sorauer, P. Handbuch der Pflanzenkrankheiten, 3 ed. **2**: 471. 1908.

Ozonium omnivorum Shear. Produces the root rot of cotton and alfalfa.

Pammel, L. H. Cotton Root-Rot. Texas Agr. Expt. Sta. Rpt. **2**: 61–86. 1889. (Also published as Bul. 7: 1–30. 1889.)

Atkinson, Geo. F. Method of Obtaining Pure Cultures of Pammel's Fungus of Texas Root-Rot of Cotton. Bot. Gaz. **18**: 16–19. 1893.

Shear, C. L., and Miles, G. F. The Control of Texas Root Rot of Cotton. U. S. Dept. Agr., Bur. Plant Indus. Bul. 102: 39–42. 1907.

Oospora scabies Thaxter. Produces scab of potatoes and beets.

Sturgis, W. C. On the Susceptibility of Various Root Crops to Potato Scab, etc. Connecticut Agr. Expt. Sta. Rpt. **20**: 263–266. 1896.

Thaxter, Roland. The Potato Scab. Connecticut Agr. Expt. Sta. Rpt. **1891**: 153–160.

Bolley, H. L. Potato Scab, Nature and Treatment. North Dakota Agr. Expt. Sta. Bul. 4: 1–17. 1891.

Fusarium Lini Bolley. Produces wilt of flax.

Bolley, H. L. Flax Wilt and Flax Sick Soil. North Dakota Agr. Expt. Sta. Bul. 50: 27–60. 1901.

Fusarium oxysporum Schlecht. Causes dry rot of potatoes.

Appel, O., and Wollenweber, H. W. Grundlagen einer Monographie der Gattung Fusarium (Link). Arb. Kais. Biol. Anst. Land-. und Forstw. **8**: 141–156. 1910.

The authors propose the new name *F. orthoceras* for the organism known in the United States as *F. oxysporum* Schlecht. The reasons for this are given.

Manns, T. F. The Fusarium Blight and Dry Rot of the Potato. Ohio Agr. Expt. Sta. Bul. 229: 299–336. 1911.

Smith, E. F., and Swingle, D. B. The Dry Rot of the Potato due to Fusarium oxysporum. U. S. Dept. Agr., Bur. Plant Indus. Bul. 55: 1–64. *pls. 1–8.* 1904.

Fusarium sp. Produces carnation stem wilt.

Atkinson, Geo. F. Carnation Diseases. Amer. Florist **8**: 720–728. 1893.

Sturgis, W. C. Preliminary Investigations on a Disease of Carnation. Connecticut Agr. Expt. Sta. Rpt. **21**: 175–181. 1897.

Fusarium vasinfectum Atk.

Atkinson, Geo. F. Some Diseases of Cotton. III. Frenching. Alabama Agr. Expt. Sta. Bul. 41: 19–29. 1892.

Butler, E. J. The Wilt Diseases of Pigeon-Pea and the Parasitism of Neocosmospora vasinfecta Smith. Mem. Dept. Agr. India, Bot. Ser. No. 9, **2**: 1–64. *pls. 1-6.* 1910.

Higgins, B. B. Is Neocosmospora vasinfecta (Atk.) Smith the Perithecial Stage of the Fusarium which Causes Cowpea Wilt? North Carolina Agr. Expt. Sta. Rpt. **32**: 100–116. *figs. 1-16.* 1909.

Orton, W. A. The Wilt Disease of Cotton and its Control. U. S. Dept. Agr., Div. Veg. Physiol. and Path. Bul. 27: 1–16. *pls. 1-14.* 1900.

——— The Wilt Disease of the Cowpea and its Control. U. S. Dept. Agr., Bur. Plant Indus. Bul. 17: 1–20. *pls. 1–4.* 1902.

Smith, E. F. Wilt Disease of Cotton, Watermelon, and Cowpea. U. S. Dept. Agr., Div. Veg. Physiol. and Path. Bul. 17: 1–53. *pls. 1–10.* 1899.

Fusarium sp.

Essary, S. H. Notes on Tomato Diseases with Results of Selection for Resistance. Tennessee Agr. Expt. Sta. Bul. 95: 1–12. 1912.

Rhizopus nigricans Ehren. Cause of soft rot of the sweet potato.

Halsted, B. D. The Sweet Potato Rot. New Jersey Agr. Expt. Sta. Rpt. **10**: 236–237. 1889.

——— Some Fungous Diseases of the Sweet Potato. New Jersey Agr. Expt. Sta. Bul. 76: 4–7. *figs. 1–2.* 1890.

——— Experiments with Soil Rot of Sweet Potatoes. New Jersey Agr. Expt. Sta. Ann. Rpt. **12**: 345–354. 1899.

This fungus is technically described and classified with the obligate saprophytes. This is due to the fact that it has frequently been isolated from the soil, and it is deemed advisable to consider it along with the other members of this group.

Thielavia basicola (B. & Br.) Zopf. Produces the root rot of tobacco, legumes, and many other plants.

Briggs, Lyman J. The Field Treatment of Tobacco Root Rot. U. S. Dept. Agr., Bur. Plant Indus. Circ. 7: 1–8. 1908.

Clinton, G. P. Root Rot of Tobacco, *Thielavia basicola* (B. & Br.) Zopf. Connecticut Agr. Expt. Sta. Rpt. **30**: 342–368. *pls. 29–32.* 1906.

Gilbert, W. W. The Root Rot of Tobacco Caused by *Thielavia basicola.* U. S. Dept. Agr., Bur. Plant Indus. Bul. 158: 1–55. *pls. 1–5.* 1909. Bibliography appended.

Zopf, W. Über die Wurzelbräune der Lupinen eine neue Pilzkrankheit. Zeitsch. Pflanzenkrank. **1**: 72–76. *figs. 1–2.* 1891.

Trichoderma Koningi Oud. Causes a disease of the sweet potato.

Cook, Mel T., and Taubenhaus, J. J. *Trichoderma Koningi* the Cause of a Disease of Sweet Potatoes. Phytopathology **1**: 184–189. *pls. 27-28.* 1911.

Obligate saprophytes

Species of Phycomycetes

Mucorales

Reproduction asexually by spores contained in sporangia. . *Sporangiophorae*
Reproduction asexually by conidia produced either solitary or in chains. . . . . *Conidiophorae*

Suborder Sporangiophorae

I. Sporangia generally only of one kind, spherical or pyriform, with a membrane that dissolves or fractures easily. Sporangioles with persistent membranes occur very rarely and in such cases are disposed without order along the principal sporangiophore. The septum separating the sporangiophore from the sporangium arches in the interior of the latter to form a columella. Zygospores naked or surrounded by appendages . . . . *Mucoraceae*
II. Sporangia as with the Mucoraceae but of two kinds: the one multispored, with membrane that dissolves, leaving only a naked columella; the other (sporangioles) few-spored, with persistent membrane, often without columella, caducous. The sporangioles are disposed at the extremity of branched sporangiophores, which are fixed at regular intervals on the principal sporangiophore. . . . . *Thamnidiaceae*
III. Sporangia of one kind only, multispored, with membrane for the major part solid, persistent, of a very dark blackish color, or swelling only toward the base. Sometimes the sporangium dissolves, leaving the columella, while at other times it is thrown off at the same time as the columella and opens only after swelling of the membrane. . . . *Pilobolaceae*
IV. Sporangia without a columella, with diffluent evanescent membrane. Zygospores contained singly in a completely closed carposporium. . . . . *Mortierellaceae*

Family Mucoraceae

1. Sporangia pyriform. . . . . *Absidia*
Sporangiag lobose. 2
2. Sporangiophores fasciculate on a rhizoidiferous stolon, located on the nodes opposite the rhizoids; spores often striated longitudinally. . . . . *Rhizopus*
Sporangiophores emerging solitary from the mycelium, no rhizoidiferous stolons; spores generally smooth without longitudinal striations. 3
3. Heterothallic, occasionally homothallic, but in this case the zygophores generally arise from comparatively distant parts of the mycelium, never formed between branches of a single aerial hypha, usually equal. . *Mucor*

Homothallic; zygophores arise comparatively close together, almost invariably originating from a single aerial hypha, usually unequal .... *Zygorrhynchus*

Absidia

Absidia Orchidis (Vuill.) Hagem, Untersuch. ü. Norw. Mucorineen **1**: 40–43. *figs. 16–18.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907. Lendner, Les Mucorinées de la Suisse, 138–140. *fig. 50.* 1908.

Syn. *Tieghemella Orchidis* Vuill., Bul. Soc. Myc. France **19**: 119-126. 1903.

This fungus varies somewhat with the substratum; stolons of different sizes, depending on the concentration of the medium; on rich substratum very strongly and richly branched; on poorer, forming shorter and only solitary new stolons; sporangiophores mostly two together, occasionally 3–4–5, always with a septum 10–20μ below the sporangium; sporangia 35–60μ high and broad (without consideration of apophysis); columella hemispherical to conical, seated on the apophysis, without the apophysis measuring 20–40μ high and broad, or occasionally 5μ broader than high; spores globose, 2.5–3.5μ diameter, in mass weak yellow or with a trace of brown.

Heterothallic; zygospores globose (80–)100–120(–150)μ in diameter; exospore with warty, starlike thickenings; suspensors formed by the stolons, with a circle of 10–14 one-celled, frequently brown appendages that interweave with those of the opposite side and surround the zygospore.

Hab. Isolated frequently from forest and meadow, and garden soil near Christiania, Norway, Hagem.

Absidia glauca Hagem, Untersuch. ü. Norw. Mucorineen **1**: 43–45. *figs. 19–20.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907. Lendner, Les Mucorinées de la Suisse, 136–138. *figs. 48–49.* 1908.

Colonies at first white, soon, however, more or less bluish green; stolons of the first order very low and slightly bent, up to several centimeters long, up to 25–30μ thick, ending for the major part with few rhizoids, producing short (1–)2(–3) new stolons, blue-green, those of the last orders frequently strongly bent; sporangiophores straight, erect, mostly two together, occasionally also several, 100–600μ high, 5–10μ thick, frequently producing one or two side branches, which are again branched. Also occasionally instead of a branch a new stolon is formed, always with a septum close to the sporangium; sporangium together with the apophysis pyriform, with easily dissolving wall; columella hemispherical, mostly without but occasionally also with a short, thick process, without apophysis 20–30μ high by 25–35μ broad; spores very small, globose, 2.5–3.5μ in diameter, in mass yellowish.

Heterothallic; zygospores globose, very variable in size, mostly about 100μ in diameter, opaque, black; exospore with large, plate-like, opaque thickenings; suspensors formed from the stolons, with a circle of 10–18 one-celled, green appendages that interweave with those of the opposite side and more or less surround the zygospore.

Hab. In light humous soil near Christiania, Norway, Hagem; Switzerland, Lendner.

Absidia Lichtheimi (Lucet et Costantin) Lendner, Les Mucorinées de la Suisse, 143–144. *fig. 52.* 1908.

Syn. *Mucor Lichtheimi* Lucet et Costantin, Arch. Par. **4**: 380. 1901.
Lichtheimia corymbifera Vuill., Bul. Soc. Myc. France, fas. 2, **19**: 119-126. 1903.
Mucor corymbifer Cohn. Lichtheim, Zeitsch. Klin. Med. **7**: 174. 1884.

Sporangiophores creeping, forming a white floccose felt, terminated by a corymb of branches that are more or less elongated and carry sporangia; shortly beneath this corymb, the branches are disposed in groups. These branches carry much smaller sporangia. Sporangia erect, hyaline, pyriform, with an infundibuliform apophysis that gradually passes into the stalk of the sporangiophore, with mean diameter 45-60μ, maximum 70μ, minimum 10–20μ; membrane of sporangium smooth, hyaline, transparent, diffluent, leaving a basal collarette; columella large, hemispherical or globose, 10–20μ, smooth (or supplied with short spines), gray, fuliginous, or brown-black. The apophysis and the pedicel have also the same tint. Spores are globose, subglobose, or more rarely oval, hyaline, small, for the major part 2 by 3μ (some larger, 4 by 6.5μ). Zygospores unknown.

Hab. Pathogen in canines. Isolated from soil, Geneva, Switzerland, Lendner.

Absidia caerulea Bainier, Bul. Soc. Bot. France, **36**: 184-186. 1889. Lendner, Les Mucorinées de la Suisse, 141. 1908.

Syn. *Pro-Absidia Saccardoi* Vuill., Bul. Soc. Myc. France, fas. 2, **19**: 119-126. 1903.
Mucor Saccardoi Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 278. 1902.

Vegetative hyphæ blue-violet, continuous, branching, unequal, sometimes nodular; sporangiophores solitary, borne directly on the mycelium, attaining 25 mm. in length, terminated by an infundibuliform apophysis, with septum 12–24μ from summit; sporangia uniform, globose, 36–42μ, passing from pale violet to grayish black and then to brown; membrane of sporangium smooth, diffluent, leaving a basal collarette; columella hemispherical or obconical, often surmounted by a nipple; spores numerous, small, smooth, pale violet, globose, 4–7μ; zygospores 60μ in diameter, brown, globose, rugose-verrucose; suspensors straight, widening into a funnel, provided with 10–20 long, slender (7μ thick) circinate appendages disposed in a single verticil; azygospores equal; chlamydospores smooth, intercalary.

Hab. Humous soil from wood near Bussum, Holland, Koning.

Absidia spinosa Lendner, Bul. Herb. Boissier ser. 2, **5**:—. 1905; Les Mucorinées de la Suisse, 132–134. *fig. 46.* 1908.

Syn. *Absidia cylindrospora* Hagem, Untersuch. ü. Norw. Mucorineen **1**: 45–46. *fig. 21.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907.

Culture forming very dense, grayish, cotton-like aerial mycelium which attains a height of 2.5 cm.; stolons slightly incurved; curves carrying sporangiophores in fascicles of 2 to 3; sporangia pyriform, measuring 34µ long without the apophysis and 28µ thick; columella 20µ thick, vase-like in form, terminated by a blunt or round point, attaining one third of the length of the columella. A septum situated 25µ below the apophysis separates the sporangia from sporangiophores; spores hyaline, oval or short cylindrical, 2 by 4–5µ.

Zygospores globose or duliform, verrucose, formed by the fusion of two unequal gametes supported by a bifurcated filament. The most vigorous suspensor alone produces prolongations or circinate appendages.

Hab. Isolated from garden soil, Geneva, Lendner; from humous soil near Christiania, Norway, Hagem.

Rhizopus

Rhizopus nigricans Ehrenberg, *Mucor Stolonifer* in Sylv. Myc. Berol., 25. 1818; *Rhizopus nigricans* in Nova Acta Acad. Leop. **11**: 198. 1820.

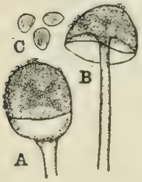

FIG. 101.—*Rhizopus nigricans Ehren. A, columella with adhering spores and apophysis, x 60;* B, *columella after becoming pileate, x 60;* C, *spores, x 236.6*

Stolons far-spreading, even growing onto and spreading over the culture glass, covering the substratum and its neighborhood with thick cobwebby growths 1–3 cm. long and occasionally still longer, simple or sparsely branched, occasionally fork-like internodes, with smooth, at first hyaline then finally brown, membrane, contents colorless; rhizoids more or less richly branched, at first with colorless, later with brown or black-brown, smooth, thick membrane, as thick as 16µ at base and 5µ at tip, finally uniseptate; sporangiophores seldom single, mostly in clusters of 3–5 occasionally up to 10, unbranched, 0.5–4 mm. high, 24–42µ thick, with smooth, finally brown or black-brown, membrane, contents colorless, with apophysis of sporangium more or less hemispherical, large, 100–350µ broad, at first snow-white then becoming at maturity black, erect; columella with broad base, very large, broadly half globose, highly arched, with apophysis 70µ broad by 90µ high to 250µ broad by 320µ high, with brown smooth membrane, often covered with spores after opening of sporangia, often becoming pileate; spores irregularly globose or broad oval, mostly with one or two blunt corners, variable in size

6–17μ in diameter, mostly somewhat longer than broad, with thick double membrane on which are seen meridian-like folds, light pale gray, contents colorless; zygospores globose or barrel-shaped, 160–220μ in diameter; exospore firm, brown-black, opaque, closely beset with half-globose high warts; endospore colorless, thick, with small outgrowths filling the warts of the exospore; suspensors swollen, commonly unequal, almost as broad as the zygospore; azygospore observed.

Isolated from soil, Norway, Hagem; Germany, Adametz; isolated repeatedly by writer from plant-breeding plats near Cornell University during winter 1910–1911. Plant pathology herbarium No. 5,895.

Rhizopus nigricans var. **minor** n. var.

Differs from type in the following particulars: Sporangiophores never attain a height of more than 2.5 mm. and a maximum thickness of 28μ (type 4 mm. maximum height by 42μ maximum thickness). The clusters of sporangiophores vary from 1 to 5, never more (type 1–5, sometimes 10). Spores are more uniform in size and constantly smaller, 4.5–10 by 4.2–6.6μ, and of a dark fuliginous color.

Hab. Soil taken from plant-breeding plats, Cornell University, Ithaca, N. Y., fall 1910.

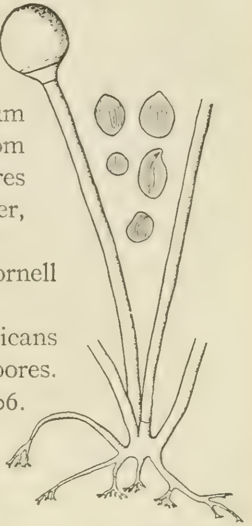

FIG. 102.—*Rhizopus nigricnas Ehren. var. minor. Showing sporangiophores, rhizoids, and columella, x 60; spores, x 533.3*

Rhizopus nodosus Namyslowski, Rhizopus nigricans et les conditions de la formation de ses zygospores. Bul. Intern. Acad. Sci. Cracovie No. 7. 1906. Lendner, Les Mucorinées de la Suisse, 122–123. *fig. 45.* 1908.

Syn. *Mucor Norvegicus* Hagem, Untersuch. ü. Norw. Mucorineen **1**: 39-40. *fig. 15.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7. 1907.

Mucor nodosus (Namy.) Hagem, Neue Untersuch. ü. Norw. Mucorineen. Ann. Myc. **8**: 280. 1910.

Mycelium at first cottony white, then finally becoming tinted with ocher-yellow. In the midst of the mycelium and on the stolons are found stalks terminated by sporangia; stalks simple or branched, the branches terminated by sporangia, often swollen at some one point, 1–2 mm. high, 12–18μ thick, with smooth, thick membrane that is hyaline at first, then finally becoming pale ocher-yellow or brown.

When the swellings are at the extremity of the stalk, they give rise to a group of 3–5 sporangiophores terminated by sporangia, sporangiophores 1–2 mm. high; sporangia round, 100–200μ in diameter, average 130μ; spores 6–9 by 4–6μ, with longitudinal stripes, giving rise, if they are sown on saccharose, to filamentous mycelium producing chlamydospores 16–34μ

in diameter. Zygospores measure 120–140μ with maximum 180μ, variable in form, being round, oval, or without any particular form. Suspensors equal or different in form and in size. (Description after Lendner.)

Hab. Glacial sediment, altitude 3,000 m., Switzerland, Lendner; tilled soil, Christiania, Norway, Hagem.

Hagem considers his *M. nodosus* and Namyslowski's *R. nodosus* as synonymous, while his *M. Norvegicus* is claimed to be a new species. On the other hand, Lendner considers all three species as identical. The cultures have not been studied by the writer.

Rhizopus arrhizus Fischer, Rab. Krypt. Flora Abt. 4, **1**: 233–234. 1892. Hagem, Untersuch. ü. Norw. Mucorineen **1**: 37–38. *fig. 14.* 1907. Lendner, Les Mucorinées de la Suisse, 121–122. *fig. 44.* 1908.

Differs from *R. nigricans* in being brighter-colored and not spreading so far over the substratum, also in the stolons being less distinct and less differentiated from the sporangiophores; stolons without distinct formation of nodes, with colorless or bright brown membrane; rhizoids pale, developed at the nodes together with the sporangiophores or alone at indeterminate places; sporangiophores ascending or trailing, seldom arising from the stolons singly but mostly 2–10 in umbels or corymbs, 0.5–2 mm. long, simple or once or twice forked, ending in sporangia; sporangia globose, large, 120–250μ in diameter, at first snow-white then finally becoming at maturity black; columella spherical, flattened on the apophysis, 40–75μ high by 60–100μ thick, with brown, smooth membrane; spores globose or oval, one- or two-angled, with longitudinally striated membrane, 4.8–7μ long by 4.8–5.6μ thick, smoky gray. (Description after Fischer.)

Hab. Isolated from soil, Hungary, Namyslowski.

Mucor

I. Sporangiophores unbranched .... *Mono-mucor*

II. Sporangiophores branched

  1. Branching rare or more frequent, and in this latter case indefinite, in clusters or in corymbs .... *Racemo-mucor*

  2. Branching definite, in sympodia .... *Cymo-mucor*

Mono-mucor

Sporangiophores not branched (exception, when the nutrition is unfavorable, branching occurs; this, however, is anomalous).

1. Sporangiophores not exceeding 2 centimeters in length 2

Sporangiophores more than 2 centimeters long 3

2. Sporangia red, 20-35μ, with diffluent membrane, spores 2.5 by 2μ .... *M. Ramannianus* Möller

Sporangia green-black, 50–80μ usually 60μ, with diffluent membrane, spores 4–10 by 2.5–5μ........................*M. hiemalis* Wehmer
Sporangia brownish, 30–80μ mostly 60μ, with nondiffluent membrane, spores 2–3 by 1.5μ..................*M. microsporus* Namyslowski
Sporangia gray, 80–95μ, with diffluent membrane, spores 8.5 by 4.5μ *M. adventitius* Oudemans
3. Sporangiophores 1–4 centimeters long, spores mostly cylindrical, 5–7 by 2.5–3.5μ............................*M. strictus* Hagem
Sporangiophores 2–15 centimeters long, spores 6–12 by 3–6μ *M. mucedo* (Linné) Brefeld

Racemo-mucor

Branching indefinite, in groups or clusters or in corymbs.
1. Sporangiophores at first erect, but soon falling......................2
Sporangiophores always erect..................................3
2. Branches of the sporangiophores ascending; sporangia 40–60μ, bright yellow, breaking, leaving a basal collar...*M. Christianiensis* Hagem
Branches of the sporangiophores mostly reflexed; sporangia 15–45μ, falling closed and remaining intact for a long time *M. dispersus* Hagem
3. Spores very unequal (mixture of numerous small spores with others twice as large), oval or subcylindrical, 4 by 2μ or 5 by 3μ to maximum 8 by 6μ.............................*M. sylvaticus* Hagem
Spores reasonably equal..4
4. Membrane of the sporangium nondiffluent.....*M. racemosus* Fresenius
Membrane of the sporangium diffluent............................5
5. Species very large, 6–8 centimeters high (always over 2 centimeters); spores 9–12 by 4.2μ............................*M. flavus* Bainier
Species much smaller, never exceeding 2 centimeters high; spores 5–7 by 2.5–3.5μ.........................*M. genevensis* Lendner

Cymo-mucor

Sporangiophores branched in sympodial cymes.
1. Sporangiophores nonerect, incurved, forming a cobwebby network, 1.5 centimeters high, ending in a large sporangium and producing at a short distance below more or less closely clustered branches; secondary branches sometimes dichotomous 2
Sporangiophores circinate......................................3
Sporangiophores straight, not circinate..........................6
2. Spores average 8μ..........................*M. botryoides* Lendner
Spores average 6μ........................*M. botryoides* var. *minor*
3. Sporangiophores never much surpassing 1 centimeter; spores oval, 6μ being maximum length.....................................4

Sporangiophores 0.5–2 centimeters long, the longer noncircinate, the shorter much branched and circinate, sporangia average 60μ, spores average 10μ............................*M. lamprosporus* Lendner

4. Membrane of the sporangium brown; sporangia often subsessile, spores oval or broad elliptical, 3–4 by 5–6μ...*M. circinelloides* van Tieghem

Sporangia supported by very long pedicels, often circinate..........5

5. Sporangia 60–80μ in diameter, spores 4–6 by 4μ.*M. griseo-cyanus* Hagem

Sporangia 50–60μ in diameter, spores 5–7 by 3.5–5μ *M. corticolus* Hagem

6. Spores globose..7

Spores oval..10

7. Species grows poorly on wort-gelatin, forms on bread a short aerial growth of 2–3 mm. high, sporangia 50–70μ in diameter, spores globose, 5–6μ..........................*M. Jansseni* Lendner

Species grows well on wort-gelatin and forms an aerial growth 1–3 centimeters high..8

8. Columella spinescent.......................*M. plumbeus* Bonorden

Columella smooth..9

9. Sporangia 70–110μ in diameter, sporangioles not caducous, spores globose, brilliant, 10μ......................*M. sphaerosporus* Hagem

Sporangia never exceeding 80 to 90μ, spores 10μ, sporangioles circinate, caducous, sporangiophores more elevated than with *M. sphaerosporus* *M. lamprosporus* Lendner

Sporangia 60–80μ, spores normally 8–10μ, spherical or accompanied by abnormal oval spores 8–10 by 30μ, no sporangioles *M. dimorphosporus* Lendner

10. Sporangia 50–350μ, columella globose, spores globose or ellipsoidal or angular, 4.2–6.5μ, chlamydospores..........*M. geophilus* Oudemans

Sporangia variable, lead-gray, those of the shorter sporangiophores 45–180μ, columella oval or ovate, spores broad ellipsoidal, 4.5–10 by 3.5–7μ usually 6.8 by 4.6μ..............*M. saturninus* Hagem

Mono-mucor

Mucor Ramannianus Möller, Untersuch. ü. ein- und zweijahr. Kiefern im märk Landboden. Zeitsch. Forst- u. Jagdw. **25**: 330. 1903. Hagem, Untersuch. ü. Norw. Mucorineen **1**: 20–21. *fig. 2.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907. Lendner, Les Mucorinées de la Suisse, 62–63. *fig. 21.* 1908.

Colonies bright rose-red, very slow-growing; sporangiophores low, 0.5–1 mm. high, either not at all or only slightly branched at the base, 1–3 septate with upper septum 15–20μ below the sporangium; sporangia red, with yellow spore mass visible through the membrane, 20–35μ in diameter;

sporangial wall readily dissolving; columella small, occasionally appearing as a hardly distinguishable swelling, globose or ellipsoidal, 6–12μ high by 6–12μ wide, average 8 by 10–11μ; spores very small, 2.5 by 2μ; zygospores not observed.

Hab. Isolated from forest soil near Christiania, Norway, Hagem.

Mucor hiemalis Wehmer, Der Mucor der Hanfrötte, *M. hiemalis* nov. spec. Ann. Myc. **1**: 37–41. *figs. 1–9.* 1903. Hagem, Untersuch. ü. Norw. Mucorineen **1**: 24–28. *figs. 5–8.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907. Lendner, Les Mucorinées de la Suisse, 65–68. *fig. 22.* 1908.

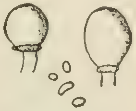

FIG. 103.—*Mucor hiemalis Wehm. Showing columellæ with basal collar, and spores, x 236.6*

Colonies bright gray; sporangiophores 0.5 cm. high, at first erect, later frequently somewhat bending down, monopodially branched with branches again branched, or also, especially in young cultures, almost entirely unbranched; sporangia green-black with a trace of yellow, 50–80μ usually about 60μ in diameter, with dissolving wall; columella, in young sporangia, globose, later always more or less oval, 20–50μ usually 30–40μ in diameter, with small basal collar; spores rather uniform in shape, but very variable in size, usually regularly ellipsoidal, occasionally flattened on one side or slightly curved, 4–10 by 2.5–5μ; chlamydospores numerous in the substratum, very irregular, pyriform, barrel-shaped, et cetera, seldom in the sporangiophores.

Heterothallic; zygospores on short, 1–2 mm. high, nonseptate hyphæ that arise from the substratum, globose, 70–100μ usually 80–90μ in diameter, warty; warts very close-standing, short-rayed, starlike, black, opaque; suspensors rather short and thick, uniform, usually straight, the one (seldom both) in certain stages of conjugation with strong red-brown contents.

Hab. Isolated frequently from soil near Christiania, Norway, Hagem; Switzerland, Lendner; Czarnohora, Austria, Namyslowski; plant-breeding plats, Cornell University, by the writer. Plant pathology herbarium No. 5,897.

Mucor microsporus Namyslowski, Studien über Mucorineen. Bul. Acad. Sci. Cracovie, Series B. Sci. Nat., 518. June, 1910.

Colonies whitish, with age becoming yellowish, especially when grown on pears; mycelium cottony; sporangiophores unbranched, up to 2 cm. high, 12–20μ thick, below the columella strongly attenuated; sporangia brownish, 30–80μ in diameter, mostly 60μ; membrane of young sporangia does not dissolve in water, with age, however, it dissolves; columella spherical, somewhat higher than broad, beneath weakly attenuated, always with flat base and short collar; smooth, 20–70μ broad, often filled with brick-red contents; spores regularly ellipsoidal, hyaline, smooth, 2–3μ long, 1.5μ broad (maximum 4μ long), in mass when young ashen-gray, with age bluish.

Hab. Isolated from meadow soil, Czarnohora, altitude 1,430 m., Galicia, Austria, Namyslowski.

Mucor adventitius Oudemans, Overdr. Nederl. Kruidk. Arch. ser. 3, **2:** 3. 1903. Lendner, Les Mucorinées de la Suisse, 64. 1908.

Sporangiophores simple, continuous, hyaline, forming a sward 2 cm. high; sporangia globose, 80–95μ in diameter, at first hyaline then much later becoming clear gray, finely echinulate, provided with a diffluent membrane; columella at first globose, much later becoming ellipsoidal or campanulate, hyaline, measuring 40–48 by 48–64μ and provided with a basal collar; spores ellipsoidal or merely oblong, 8–8.5 by 4.5–5μ, smooth, hyaline, grayish black when in mass. Zygospores and chlamydospores not observed.

This species resembles *M. mucilagineus* Bref., from which it differs by its much smaller spores (8–8.5 by 4.5–5μ as against 30–33 by 15μ) and by the absence of interstitial mucilaginous protoplasm.

Hab. Isolated on exposed gelatin in the woods called Spanderswoud near Bussum, Holland, Koning.

var. *aurantiaca* Lendner, l. c.

Differs from species in containing guttulæ of a yellow-orange color.

Hab. Isolated from forest, Canton of Vaud, Switzerland, Lendner.

Mucor strictus Hagem, Untersuch. ü. Norw. Mucorineen **1:** 18–19. *fig. 1.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907. Lendner, Les Mucorinées de la Suisse, 97–98. 1908.

Sporangiophores erect, 1–4 cm. high, 25–40μ thick, forming dense silver-white colonies, unbranched or also frequently with a single branch, mostly nonseptate; sporangia at first wax-like white, at maturity black, 200–300μ in diameter, fine-spiny; membrane dissolving, leaving at base of columella a collar; columella seldom globose, mostly oval or ovate with somewhat smaller base, in young sporangia with fine granular contents, in mature sporangia mostly without contents and with smooth membrane, 100–160μ high and 80–140μ broad, spores variable, seldom globose or oval, of 3.5–7.5μ diameter, mostly, however, regularly cylindrical, almost twice as long as broad, 5–7μ long by 2.5–3.5μ broad; zygospores unknown.

Hab. Acid soil of spruce woods, Norway, Hagem.

Mucor mucedo (Linné p. p.) Brefeld. For synonymy and literature see Fischer in Rab. Krypt. Flora Abt. 4, **1:** 186–190. 1892. Hagem, Untersuch. ü. Norw. Mucorineen **1:** 18. 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907.

Sporangiophores erect, with colorless membrane and colorless or weak-yellow scanty contents, forming a thick silver-gray glistening sward over the entire substratum, usually unbranched, 2–15 cm. long by 30–40μ thick, nonseptate, occasionally, especially the first from young mycelium, much shorter and with a side branch; sporangia large, globose, 100–200μ in diameter, at first yellowish, later when dry becoming dark gray or black-brown, occasionally with greenish shimmer, thick fine-spiny; sporangial wall quickly dissolving, leaving generally a basal collar; columella high-cylindrical or bell-shaped or globose, 70–140μ high by 50–80μ broad, with smooth, colorless membrane and mostly with orange-yellow contents; spores round cylindrical to long ellipsoidal, twice as long as broad, very uniform in shape, variable in size 6–12 by 3–6μ (extreme forms 16.8μ long), with colorless smooth membrane, weak-yellow or colorless contents.

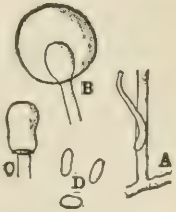

Fig. 104.—*Mucor mucedo (Linné) Bref.* A, *part of sporangiophore, showing occasional branching, x 60;* B, *sporangium, x 60;* C, *columella, x 60;* D, *spores, x 236.6*

Heterothallic; zygospores globose, 90–250μ in diameter; exospore black, with thick projecting tubercles; endospore colorless; contents colorless, with large oil drop; zygospores in our cultures not observed.

Hab. Isolated from soil by Hagem, near Christiania; Cracovie, Austria, Namyslowski; Germany, Adametz; by the writer frequently from oat field and experimental plats of Plant-Breeding Department, New York State College of Agriculture, Cornell University, Ithaca, N. Y. Plant pathology herbarium No. 5,898.

Racemo-mucor

Mucor Christianiensis Hagem, Neue Untersuch. ü. Norw. Mucorineen. Ann. Myc. **8**: 268–272. *figs. 2–3.* 1910.

Colonies on agar consisting first of a thick gray mycelial membrane covering the surface of the substratum, finally there occurs a sparse formation of sporangiophores. Sporangiophores mostly scattered, seldom forming loose tufts 1.5–2.5 cm. high, generally thin 6–10μ thick and therefore soon falling, when young unbranched, older monopodially branched with few short upward-bent branches, with numerous chlamydospores, at maturity finally breaking into pieces. Chlamydospores in the sporangiophore at first cylindrical, later barrel-shaped or mostly spherical, rather regularly interspersed every 50–200μ, at maturity quickly becoming ripe and free. Sporangia small, usually 40–60μ in diameter, at maturity of bright yellow color, with wall that breaks, leaving finally only a collar at the base of the columella. Columella oval or mostly ovate, toward the broad flat base somewhat cylindrical, always higher than broad, 30–45μ, occasionally 50μ high and 20–40μ broad, usually 25–30μ. Spores broad, oval, or also a few almost globose (4–5–)6–9(–12) by (4–)5–7(–9)μ. Zygospores unknown. Does not invert cane sugar.

Hab. Isolated several times from garden and flowerpot soil in the Botanical Gardens of Christiania, still very rare, Hagem.

Mucor dispersus Hagem, Neue Untersuch. ü. Norw. Mucorineen. Ann. Myc. **8**: 272–275. *figs. 4–6.* 1910.

Sporangiophores forming none or slightly dense tufts (rasen) of different heights; the greater, 2–3 cm. high, very scattered, ascending, extremely thin (4–)5–7(–9)μ thick, waving to and fro, mostly soon dropping down, clustered, monopodially branched, with short, reflexed, frequently one-time-branched branches, chief branches as well as twigs ending in sporangia; the smaller, 1–2 mm. high, mostly reflexed, with small sporangia. End sporangia of the taller sporangiophores small, 50μ, with easily dissolving wall and smaller, usually blunt and broad spherical, seldom oval, columella (14–15–)17–19(–21)μ high and (14–15–)18–21(–27)μ broad. Basal collar present.

Sporangia of the side branches, as well as those of short sporangiophores, of very different size, 15–45μ, spiny, with nondiffluent membrane, with transparent spore mass that is frequently very small, 15μ, and containing only 2–4 spores, but also greater spore mass 30–45μ with numerous spores, mostly falling closed and remaining intact for a long time.

Spores of variable dimensions (9–10–)11–13(–15–18)μ, usually round or slightly long, sometimes roundish angled. Substratum mycelium, with peculiar long, frequently 100–200μ thick, swellings filled with oil drops.

Heterothallic; zygospores unknown. Hybridizes with *M. lamprosporus* Lendner. Inverts saccharose.

The swellings are very characteristic. The oil drops form near a septum, back of this is then laid down another septum.

Hab. Isolated only once in Norway from the deep soil. Closely related to *M. lamprosporus* Lendner.

Mucor sylvaticus Hagem, Untersuch. ü. Norw. Mucorineen **1**: 1–34. *figs. 11–12.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907. Lendner, Les Mucorinées de la Suisse, 74–75. *fig. 26.* 1908.

Colonies gray-white; sporangiophores erect, forming a dense growth over the entire substratum, 1–15 cm. high, always sympodially branched, with alternating right and left sporangial stalks that are separated from the further growing branches by a septum at the base; sporangial stalks straight, only seldom slightly curved, 200–500μ long, ascending, forming an angle of 30–50° with the chief axis of the sympodium; sporangia never sessile, yellow-green to weak black-green, globose, 45–70μ in diameter with more or less plain basal collar and likewise as the sporangial stalk with smooth wall and colorless contents; spores oval or subcylindrical, 4 by 2μ or 5 by 3μ (to maximum 8 by 6μ).

Heterothallic; zygospores produced ladder-like on the sporangiophores, black, opaque, with plate-like, slightly raised elevations; azygospores numerous, seldom single, mostly double.

Hab. Isolated frequently from acid soil of forests near Christiania, Norway, Hagem.

Mucor racemosus Fresenius, Beitr. Myc. 12. 1850. Fischer, Rab. Krypt. Flora Abt. 4, **1**: 192–194. 1892. Hagem, Untersuch. ü. Norw. Mucorineen **1**: 24. 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907. Lendner, Les Mucorinées de la Suisse, 77. 1908.

Sporangiophores rigid, erect, 5–40 mm. long by 8–20μ thick, branched, with side branches sometimes branched; in mass dirty light yellowish; sporangia small, spherical, 20–70μ in diameter, erect, single, often reflexed, dirty yellow, wax yellow, or yellowish brown, transparent, sporangial wall smooth, not dissolving in water, but breaking open, often remaining long intact; columella hyaline, broad clavate to short ovate, 14–60μ long by 7–45μ broad, occasionally spherical or broad campanulate, with colorless smooth membrane; spores hyaline to dirty yellow, short ellipsoidal to globose, sometimes somewhat angled, variable in size 4–8 by 4–10μ, smooth.

Heterothallic; zygospores globose, 70–85μ in diameter, brown, warty exospore, suspensors smaller than spore; chlamydospores globose to oblong, globose measure 10–20μ, oblong 10–20 by 25–30μ, hyaline or yellowish guttulate, thick, smooth membrane.

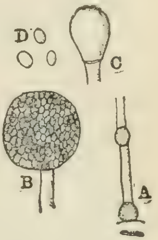

FIG. 105.—*Mucor racemosus Fres.* A, *part of sporangiophore, showing chlamydospores, x 236.6;* B, *sporangium, x 236.6;* C, *columella, x 236.6;* D, *spores, x 236.6*

Hab. Isolated from sandy and loamy arable soil, Germany, Adametz; from sandy-loamy soil from potato field, Long Island, N. Y., by the writer. Plant pathology herbarium No. 5,899.

Mucor flavus Bainier, Sur quelques espèces de Mucorinées nouvelles ou peu connues. Bul. Soc. Myc. France **19**: 158. 1906. Hagem, Untersuch. ü. Norw. Mucorineen **1**: 21–22. *fig. 3.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907. Lendner, Les Mucorinées de la Suisse, 79. 1908.

Sporangiophores attain on sterilized bread a height of 6 cm. and are usually 25–35μ thick, monopodially branched with long ascending branches that are again occasionally branched, in young cultures colorless, in old, yellow; sporangia at first white, then becoming blue-gray and finally yellow; columella in young sporangia frequently globose, in mature sporangia, however, always oval or ovate with somewhat smaller base, 75–110μ high by 60–90μ broad; spores are rather uniform in shape, mostly oval or ellipsoidal, seldom cylindrical, occasionally somewhat flattened or curved, twice as long as broad, very variable in size, 5–12 by 3–6μ (mostly 9–10 by 4–5μ). There occur besides also in the cultures globose spores 4–5μ in diameter; zygospores not observed.

Hab. Isolated from forest soil near Christiania, Norway, Hagem; Switzerland, Lendner.

Mucor genevensis Lendner, Bul. Herb. Boissier No. 1, **8**: —. 1908; Les Mucorinées de la Suisse, 80–82. *fig. 27.* 1908. Hagem, Neue Untersuch. ü. Norw. Mucorineen. Ann. Myc. **8**: 275–277. *fig. 7.* 1910.

Colonies with rich or sparse formation of sporangiophores; sporangiophores erect, monopodially branched with longer or shorter side branches, rather thin, 8–15μ thick, usually 1–2 cm. high, ending in sporangia. Sporangial membrane easily dissolving in water, usually there remains on the columella an irregular basal collar. Columella colorless, hyaline, either more or less spherical or also oval to obovate, 20–40μ high, 20–35μ broad. Spores small, ellipsoidal, usually twice as long as broad, (4–) 5–7(–9–10)μ long and (2–)2.5–3.5(–4)μ broad, almost hyaline.

Homothallic; zygospores produced between especially low (1 mm. high) zygophores. Suspensors as well as gametic cells almost of the same size and form, or slightly different. Zygospores spherical or laterally somewhat compressed; immature ones yellow-brown, transparent, mature ones black and opaque with rather high, starlike, thickened tubercles (60–)70–90(–100)μ high and (45–)60–70(–90)μ wide.

Hab. Found in Norway but once. Isolated from the soil of a fir wood in the neighborhood of Hauersaeter railroad station, Hagem; by Lendner in neighborhood of Geneva, Switzerland, from soil.

This species claims an especial interest because of the monœcious nature of its mycelium. The zygospores are always richly developed in culture. Hagem established this by repeated cultures from a single spore.

Cymo-mucor

Mucor botryoides Lendner, Nouvelles Contributions à la Fl. Crypt. Suisse. Bul. Soc. Bot. Genève ser. 2, **2**: 79–81. *fig. 4.* 1910.

Sporangiophores nonerect, incurved, forming a cobwebby network, attaining 1.5 cm. in height, not varying far from 16 to 20μ in diameter, ending in a large sporangium and producing at a short distance below the sporangium more or less closely clustered branches that are terminated by sporangia; secondary branches are sometimes dichotomous or sometimes in sympodia; sporangia globose, clear gray, with membrane of the large as well as the small sporangia diffluent in water, average size of the terminal

80μ in diameter; the lateral sporangia are variable and some are very small; columella variable in form and size, hyaline, globose, campanulate or panduriform, 60 by 44μ, or 55 by 38μ, or 30 by 20μ, and much smaller, usually without basal collar; spores hyaline, globose, average 8μ, maximum 10μ, not rarely encountered as small as 5–6μ; appearing polyhedral because of their surface presenting very slight roughness.

Hab. Isolated from soil, Geneva, Switzerland, Lendner.

var. **minor** n. var.

Differs from species in having brownish black sporangia, thicker sporangiophores (up to 30μ), and in the smaller spores, which appear perfectly smooth. Spores average 6μ in diameter, extremes 8μ and 4.5μ; chlamydospores of mycelium lemon-shaped, 16–22 by 10–16μ.

Hab. Isolated from soil of plant-breeding plats, Cornell University, November and December, 1910, and from flowerpot soil from horticultural greenhouses, March, 1911, Ithaca, N. Y., by the writer. Plant pathology herbarium No. 5,900.

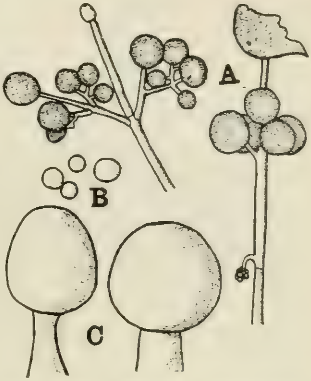

FIG. 106.—*Mucor botryoides Lendner var. minor.* A, *sporangiophores, showing sporangia and method of branching, x 90;* B, *spores, x 355;* C, *columellæ, x 355*

Mucor lamprosporus Lendner, Bul. Herb. Boissier No. 1, **8**: —. 1908; Les Mucorinées de la Suisse, 92–93. *fig. 33.* 1908.

On 10 per cent wort-gelatin, the colony forms a pale gray, dense sward 3 cm. above the substratum; sporangiophores very irregularly branched in clusters or sympodia. Part of the branches situated at the level of the substratum carry the small circinate sporangia (30–40μ in diameter), which are indehiscent and deciduous. When they are numerous, the substratum appears velvety and greenish black; the large sporangia are diffluent in water, leaving a basal collarette, 60μ in diameter (maximum 90μ); columella globose or ovoid, often broader at the base than at the summit, 20μ in diameter, or 24 by 28μ; spores hyaline, transparent, very refringent, globose, large, mean diameter 10μ, maximum diameter 12μ, minimum 7μ.

Hab. Forest soil, summit of Vuache, Savoie, Lendner.

Mucor circinelloides van Tieghem, Nouvelles Recherches sur les Mucorinées. Ann. Sci. Nat., Bot. Ser. 6, **1**: 94. 1875. Fischer, Rab. Krypt. Flora Abt. 4, **1**: 204. 1892. Hagem, Untersuch. ü. Norw. Mucorineen **1**: 34–37. *fig. 13.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907.

Sporangiophores of different form and different height, shorter, mostly 2–5 mm. high, pure sympodially branched; branches usually 5–6, alternating right and left, short, often appearing as sessile, straight or slightly bent or curved; longer sporangiophores 0.5–1.5 cm., irregularly monopodially or sympodially branched; sporangia globose, at first light brown then becoming gray-brown, those of longer sporangiophores with dissolving membrane while those of the shorter possess a firm membrane and often fall intact; membrane either finely spiny or smooth; columella sessile, globose, hyaline, smooth, 15–42μ in diameter depending on size of sporangium; spores oval or broad ellipsoidal, 3–4 by 5–6μ, smooth, singly hyaline, in mass weak gray.

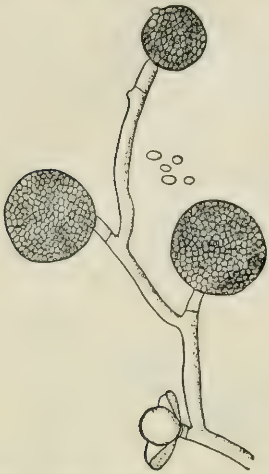
FIG. 107.—*Mucor circinelloides van Tiegh. Showing method of branching of sporangiophore, sporangia, columella with collar, and spores, x 236.6*

Heterothallic; zygospores globose; exospore red brown, with long thorn-like pointed warts that are streaked longitudinally; chlamydospores intercalary, barrel-shaped, smooth, hyaline. Zygospores not observed in our cultures.

Hab. Isolated in July, 1910, and March, 1911, from oat field and experimental plats of Plant-Breeding Department, Cornell University, Ithaca, N. Y., by the writer. Plant pathology herbarium No. 5,901.

Mucor griseo-cyanus Hagem, Untersuch. ü. Norw. Mucorineen **1**: 28–29. *fig. 9.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907. Lendner, Les Mucorinées de la Suisse, 86–87. *fig. 29.* 1908.

Colonies grown at room temperature (15° C.) blue-gray, at 20–25° C. deep black-blue; sporangiophores at first erect, soon, however, sinking down, 2–3 cm. long, 8–12μ thick, sympodially branched with branches again richly branched, generally with a septum on the main branch just above place of origin of side branches; sporangia globose, at maturity deep blue-black, opaque, with spore mass invisible, 60–80μ in diameter; sporangial wall blue-gray to blue-black, incrusted, dissolving, breaking, or remaining intact; columella mostly globose, seldom somewhat oval, 30–45μ in diameter, with smooth membrane and colorless contents; spores oval or broad ellipsoidal, 4–6 by 2.5–4μ; zygospores unknown.

Hab. Isolated from humous soil near Christiania, Norway, Hagem; Canton of Geneva, Switzerland, Lendner.

Mucor corticolus Hagem, Neue Untersuch. ü. Norw. Mucorineen. Ann. Myc. **8**: 277–279. *fig. 8.* 1910.

Colonies gray or weak blue-gray. Sporangiophores erect, up to 2 cm. high, sympodially branched with few long branches, ending in a sporangium. Side branches long (2–3 times as long as with *M. sylvaticus*), usually 600–1,500μ long by 10–15μ thick, frequently more or less reflexed and ending in sporangia. Sporangia spherical, 50–60 (–70)μ in diameter, with quickly dissolving membrane. Columella ovate or suboval, almost always 3–6μ higher than broad, 27–33μ broad and 30–36μ high, with or without colorless contents and usually with an inconspicuous basal collar. Spores oval or ellipsoidal (larger than with *M. sylvaticus*), 5–7 (–8) by 3.5–5 (–6)μ. Zygospores unknown.

Hab. Especially numerous in old decaying bark of conifers, and in old wood as well, seldom in the soil, Norway, Hagem.

Mucor Jansseni Lendner, Bul. Herb. Boissier ser. 2, **7**: —. 1907. Les Mucorinées de la Suisse, 88–89. *fig. 30.* 1908.

Sporangiophores 2–6 mm. high, branched in corymbs or sympodia with each branch ending in a sporangium, with membrane having oblique striæ; sporangia dark bluish black, 50–70μ in diameter, with finely granulated, nondissolving, but fracturing, membrane; columella sometimes spherical with widened flat sessile base, sometimes more elongated and conical, dark black or grayish, maximum 30μ broad by 34μ long, the smaller proportionately longer, measuring 20μ broad by 26μ long; spores globose, generally 5 to 6μ in diameter, the smallest 3–4μ in diameter.

Hab. Soil of the Janssen Cabin, summit of Mt. Blanc, 4,810 m., summer 1906, Lendner.

Mucor plumbeus Bonorden, Abh. Naturf. Gesell. Halle **8**: 109. 1864.

Syn *Mucor spinosus* van Tieghem, Ann. Sci. Nat. ser. 6, **4**: 390. 1876.
Mucor aspergilloides Zopf, Verh. Bot. Ver. Brandenb. **23**: 22. 1881.

Sporangiophores rigid, erect, thick, up to 1 cm. high, mixed monopodially and cymose-sympodially branched with all branches ending in sporangia, straight, seldom bending or reflexed, with a septum at the base, with hyaline smooth membrane, hyaline contents; sporangia globose, small, up to 100μ in diameter, at first hyaline, at maturity dark brown or black, finely spiny, membrane dissolving, basal collar; columella sessile, long cylindrical or pyriform, with one or more irregular, straight or bent spines on the summit, 22–85 by 8–65μ, membrane weak smoke-gray or brownish, contents hyaline; spines up to 5μ in length; spores globose, yellow-brownish, exospore with irregular folds. Chlamydospores are not infrequent as with *M. racemosus*, also on the sporangiophore up to the columella.

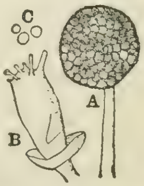

FIG. 108.—*Mucor plumbeus Bonord.* A, *sporangium, x 236.6;* B, *columella, showing collar and spines, x 236.6;* C, *spores, x 236.6*

Hab. Isolated from soil of plant-breeding experimental plats, Ithaca, N. Y., by the writer, in November, 1910; also by Hagem in Norway. Plant pathology herbarium No. 5,902.

Mucor sphaerosporus Hagem, Untersuch. ü. Norw. Mucorineen **1:** 22–24. *fig. 4.* 1908; reprint from Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 1907. Lendner, Les Mucorinées de la Suisse, 92. 1908.

Colonies yellow-brown or brown; sporangiophores of very different height, partly short only 1–2 mm. high, partly up to 1 cm. high; the latter, however, frequently scattered or united in clusters, at first erect, soon, however, especially in the upper half, sinking down, richly monopodially branched with long, repeatedly branched branches; sporangia globose, 70–110μ in diameter, yellow-brown, with easily dissolving wall; columella ovate, toward the base somewhat attenuated, 40–65μ high by 30–55μ broad, with mostly weak yellow-brown thick membrane; spores globose, variable in size even in the same culture, 10(6–8)μ in diameter, solitary or in mass slightly yellow; chlamydospores in the sporangiophores with a large central oil drop; zygospores unknown.

Hab. Isolated from soil, Christiania, Norway, Hagem.

Mucor dimorphosporus Lendner, Bul. Herb. Boissier **8:** —. 1908; Les Mucorinées de la Suisse, 93–94. *fig. 34.* 1908.

Colonies on wort-gelatin grayish, attaining a height of 2 cm. above the substratum; sympodially branched sporangiophores straight, 2 cm. long, 12μ thick. Near the substratum are found other sporangiophores that are wavy and even circinate, carrying much smaller sporangia. Normal sporangia spherical, maximum 80μ, often wider than high, mean 60μ wide by 58μ high; membrane diffluent; spores ordinarily globose, 8–10μ in diameter, often also oval 6 by 8μ or 8 by 10μ, hyaline or light yellowish, brilliant. Abnormal spores measure up to 30μ long by 8–10μ wide, very irregular; columella often much larger toward the basal part, 20 by 24μ to 40 by 50μ, oval, surrounded by a collarette; chlamydospores ovoid. Zygospores unknown.

Hab. Soil of the Janssen Cabin, summit of Mt. Blanc, 4,810 m., summer 1906, Lendner.

Mucor geophilus Oudemans, Arch. Néerl. Sci. Nat. ser. 2, **7:** 278. *pl. 5, fig. 1.* 1902. Lendner, Les Mucorinées de la Suisse, 97. 1908.

Colonies at first white, later grayish, and finally dilute olive; vegetative hyphæ dichotomously branched, continuous, dilute olive, with homogenous protoplasm; fertile hyphæ concolorous, at first simple, then passing to cymose-branched, branches usually few (2–3), continuous; sporangia globose, at first yellowish, afterward olive, dissolves leaving a basal collar, 50–350μ in diameter, spiny; columella exactly spherical, large, very dilute fuliginous; spores pluriform, globose, angular, or ellipsoidal, 4.2–6.5μ in diameter, very dilute olivaceous, smooth; chlamydospores in the mycelial branches intercalary, globose, with granular protoplasm, 20μ in diameter, sometimes solitary and sometimes in aggregations. Zygospores as they are seen are somewhat similar to chlamydospores, being slightly larger.

Hab. Isolated from soil of woods called Spanderswoud near Bussum, Holland, Koning.

Mucor saturninus Hagem, Neue Untersuch. ü. Norw. Mucorineen. Ann. Myc. **8**: 265. 1910.

Colonies always more or less dark-colored, usually lead-gray or lead-black, occasionally, however, also blue-black. Sporangiophores in the same colony of very different heights, part lower and part higher, the lower only 1–2 mm. high, usually richly but irregularly monopodially or sympodially branched, and lead-black or blue-black tufts are formed as a consequence of the large sporangia, the higher (2–3 cm. high sporangiophores) are more or less scattered, 20–25μ thick and at the beginning erect, later somewhat bent, curved, monopodially branched with long branches and of a characteristic height, lead-gray color (saturninus); sporangia of the lower sporangiophores at first bright wax-yellow, then blue-gray, and at maturity almost black, of very different sizes, usually 45–180μ in diameter, with a plain, spiny membrane that remains intact in water or breaks; sporangia of the higher sporangiophores, on the contrary, have membranes that easily dissolve in water, leaving a collar at the base of the columella. Columella oval or ovate, seldom more cylindrical in the sporangia of the higher sporangiophores, frequently toward the base smaller, 60–100μ high by 50–90μ broad, in the sporangia of the lower or shorter sporangiophores, on the contrary, somewhat smaller, 35–70μ high by 25–50μ broad. Spores regularly broad ellipsoidal, extremes 4.5–10 by 3.5–7μ usually 6–8 by 4–6μ. In addition there are frequently single small spherical spores 4–4.5μ in diameter. Zygospores unknown.

Hab. Rare. In the upper humous layers of soil in Norway, Hagem.

Zygorrhynchus

Zygorrhynchus Vuilleminii Namyslowski, Zygorrhynchus Vuilleminii une Nouvelle Mucorinée Isolée du Sol et Cultivée. Ann. Myc. **8**: 152–155. *figs. 1-9.* 1910.

The fungus develops more luxuriantly on bread than on agar. It covers the bread with a thick felt and tuft of hyphæ that attain 0.5 cm. in height. The hyphæ at first are white, later they become gray. On agar, the mycelium is cottony, at first white, then gray, and black with age.

Sporangiophores are hyaline, smooth, flexible, pendant or straight, septate, 5–14μ in diameter, variable in length; sporangia are spherical, attaining a diameter of 70μ, ordinarily 30–50μ, terminal, in general, the largest; membrane covered with needles of calcium oxalate, never dissolving in water when young, but does at maturity often leaving a basal collar; columella flattened oval, rarely spherical, ordinarily broader than high, breadth 12–30μ sometimes attaining 35μ; spores are ellipsoidal 2 by 4μ, hyaline, occasionally a few are globose 2.5 by 2.5μ.

Chlamydospores (developed in mycelium) solitary or in chains, size and form variable; the ovoid or spherical ones are on the average 12 by 20μ, the barrel-shaped 40 by 14μ and ordinarily united in chains. Zygospores formed from copulation of two unequal gametes, (20–)40–50 (–60)μ, the exospores brownish, covered with tubercles 2–3μ high and truncate. Azygospore frequently and often irregularly developed on the ends of solitary hyphæ, which continue to grow and produce a second azygospore, polymorphic and always smaller than the zygospore.

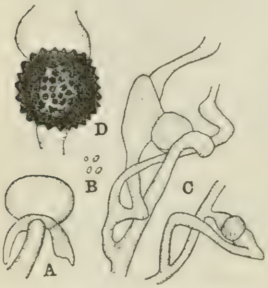

Fig. 109.—*Zygorrhynchus Vuilleminii Namy.* A, *columella and collar, x 236.6;* B, *spores, x 236.6;* C, *showing method of formation of zygospores, x 236.6;* D, *mature zygospore, x 236.6*

Hab. Isolated from Montenegro soil by Namyslowski; by the writer from the plant-breeding experimental plats of Cornell University, Ithaca, N. Y., April, 1911. Plant pathology herbarium No. 5,903.

Description is after Namyslowski's except as to height of hyphæ on bread, diameter of sporangiophores, disposition of the tubercles on the exospores, and size of the sporangia. The author found the culture attaining a height of 0.25 cm. on bread; our culture attains a height of 0.5 cm.; sporangiophores are 5–14μ as against 5–8μ. Sporangia show maximum of 70μ as against 60μ, with the tubercles varying in arrangement from groups to no groups at all. The original description claims groups only. For these reasons the species is emended as given in this description.

Zygorrhynchus Moelleri Vuillemin, Importance taxinomique de l' appareil zygospore des Mucorinées. Bul. Soc. Myc. France, **19**: 117–118. 1903.

Differs from *Z. Vuilleminii* only in the size of the spores. Spores are ellipsoidal, straight or slightly curved, 3 by 5–7μ.

We have retained these two species in this work, and leave to the special student of the Mucorineae whether they shall be so considered or whether they are to be taken as varieties of one species. These cultures have been carried on similar media for many months and still retain this constancy.

Hab. Isolated from soil shipped from East Hampton, Long Island, N. Y., October, 1910, by the writer; also in Norway by Hagem. Plant pathology herbarium No. 5,894.

Family Thamnidiaceae

Thamnidium elegans Link, Observ. in Ord. Plant. Nat. **1**: 45; Berliner Magaz. Naturf. Freunde **3**: 21. 1809. Fischer, Rab. Krypt. Flora Abt. 4, **1**: 241–244. *fig. 41.* 1892.

Sporangiophores erect, ending in large sporangia. Below these, in the middle or under part of the sporangiophore are generally 2–5 verticillate horizontal side branches that are forked several times (2–10) after an obtuse-angled fashion. The branchlets finally end in sporangioles. The whole sporangiophore is usually 0.5–3 cm. occasionally 6 cm. high by 25–35μ thick. The white floccose group of forked verticillate branches are relatively very small, 0.25–1 mm. broad. The main verticillate branches up to the forking are 150–200μ long by 8μ thick; the forks of the first order are 40–60μ long; the forks of the last order are only 4–6μ long by 2μ broad. The membrane of the sporangiophore and its branches is colorless and smooth; contents are also colorless. Branching of the sporangiophore is very variable (see variation below). Chief sporangia (hauptsporangia) globose, large, 100–200μ diameter, occasionally smaller, at maturity white with large ovate or bell-shaped, colorless, smooth columella; sporangioles globose, small, white, 8–16μ in diameter, mostly 4-spored, varying, however, from 1 to 10; spores of hauptsporangia and sporangioles similar and equally large (except in the one-spored sporangioles where they are globose, 8–16μ), ellipsoidal, 8–10μ by 6–8μ, smooth, weak gray-brown. Zygospores are globose, black, with thick black warty exospore and yellowish endospore. Zygospores not observed in our cultures.

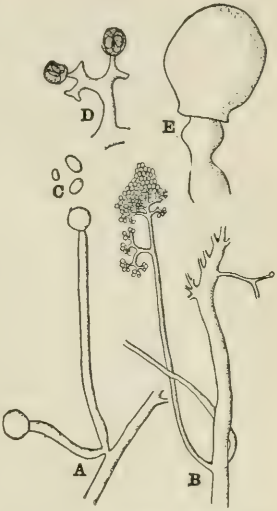

Fig. 110.—*Thamnidium elegans Link.* A, *sporangiophore and hauptsporangia, x 60;* B, *sporangiophore and nebensporangia, x 60;* C, *spores from nebensporangia, x 236.6;* D, *ultimate divisions of sporangiophore, with sporangioles, x 236.6;* E, *columella of hauptsporangium, x 236.6*

Hab. Isolated from pepper root taken from soil of plant-breeding plats of Cornell University, Ithaca, N. Y., March, 1911, by the writer. Plant pathology herbarium No. 5,904.

Variation of sporangiophores.— The branching of the sporangiophores is very variable. In one extreme case the sporangiophore carries only the chief sporangium, when it resembles an ordinary Mucor; in the other case the chief sporangium is wanting, the sporangiophore ending then either with a crown of sporangioles or with a sterile tip. Occasionally the first side branch ends in a sporangium, again the branches of the second order end thus, and again the number and order of the branching is manifold.

Family Pilobolaceae

Pilaira anomala (Cesati) Schröter, Schles. Krypt. Flora **3**: 211. 1886.

Syn. *Pilobolus anomalus* Cesati, Rab. Herb. Myc. Ed. **1**: 1542. 1851.
Ascophora Cesatii Coemans, Mem. Acad. Belg. **30**: 63. 1861.
Pilobolus mucedo Brefeld, Untersuch. **1**: 27. **4**: 66. 1872.
Pilaira Cesatii van Tiegh. Ann. Sci. Nat., Bot. Ser. **1**: 51. 1875.
Pilaira Cesatii Bainier, Etude, 29. 1882.
Pilaira Cesatii Grove, Midland Nat. **1884**: 37.
Pilaira anomala Berlese & de Toni, Sacc. Syll. Fung. **7**: 188. 1888.

Sporangiophores at first erect but soon falling and forming over the whole substratum a high, loose, hyaline, woolly, interwoven mass, usually 10–12 cm. long but even attaining 20 cm., cylindrical, 30–80μ thick, without basal and subsporangial swelling, with colorless, thin, slightly wavy membrane, at the time of maturity of spores without contents. Sporangium at first white, then becoming yellow and finally at maturity black, with colorless base, when moist globose, 100–250μ in diameter, when dry half-globose, many-spored; columella 100–150μ broad by 40–60μ high, depressed half-globose or knot-like, smooth, colorless; spores long oval, 8–13 by 5–8μ, solitary, hyaline, in mass yellowish, with colorless thin smooth membrane; zygospores at maturity black, round or slightly oval, 120μ long by 100μ broad, with smooth thick colorless endospore and black warty epispore, germination with short sporangiophore.

Hab. Isolated from forest soil, Holland, Koning.

Family Mortierellaceae

Mortierella subtilissima Oud., Contrib. Fl. Myc. des Pays-Bas ser. 2, **19**: 876. 1901; Arch. Néerl. Sci. Nat. ser. 2, **7**: 277–278. *pl. 4, figs. 1–3.* 1902. Lendner, Les Mucorinées de la Suisse, 156. 1908.

Colonies similar to *M. pusilla*, vegetative hyphæ, hyaline, continuous, branched, 3–5μ thick, with homogenous protoplasm; fertile hyphæ strict, continuous, hyaline, 130–200μ thick, simple, cylindrical, not thickened downward nor hardly attenuate upward, ending singly in sporangia; sporangia globose, smooth, 20–30μ in diameter, membrane hyaline; spores smooth, hyaline, 2.3–4.6μ in diameter, commingled with elliptical ones 5–6 by 4–5μ.

Hab. Isolated from humous soil from Spanderswoud near Bussum, Holland, March, 1901, Koning.

Differs from *M. pusilla* in vegetative hyphæ having homogenous, never granulate, protoplasm; in the slender conidiophores (2.3–3.5 against 5μ) being equally thick their entire length; in the sporangia being smaller

(20–26μ against 24–28μ), and the smaller globose spores commingled with the larger elliptical ones.

Mortierella pusilla Oud., Contrib. Fl. Myc. des Pays-Bas ser. 2, **19**: 876. 1901; Arch. Néerl. Sci. Nat. ser. 2, **7**: 277. *pl. 3, fig. 1.* 1902. Lendner, Les Mucorinées de la Suisse, 155–156. 1908.

Colonies orbicular, constantly snow-white, floccose with few superposed layers that are repand or lobate, the layers diminish in number toward center; vegetative hyphæ hyaline, 2.5–10μ thick, dichotomously branched, with protoplasm dense and full of minute granules; fertile hyphæ, 4–6μ in diameter, downward slightly thickened, upward slightly attenuate, 130–170μ high, terminating singly in sporangia; sporangia globose, smooth, 24–28μ in diameter, membrane hyaline; spores globose, smooth, hyaline, 2–2.5μ in diameter, variously guttulate to not at all.

Hab. Isolated from humous soil from Spanderswoud near Bussum, Holland, March, 1901, Koning.

Differs from *M. isabellina* in colonies having lamellate texture and being constantly white; in vegetative hyphæ having dense protoplasm that is full of minute granules; in conidiophores being attenuate toward tip; and in having hyaline spores.

Mortierella isabellina Oud., Contrib. Fl. Myc. des Pays-Bas ser. 2, **19**: 875. 1901; Arch. Néerl. Sci. Nat. ser. 2, **7**: 276. *pl. 2, fig. 1.* 1902. Lendner, Les Mucorinées de la Suisse, 156–157. 1908.

Colonies zonate, at first white, then bright gray, finally isabel-colored (Sacc. Chromot. No. 8), somewhat rougher with age; vegetative hyphæ dichotomously branched, continuous, with protoplasm equally dense; fertile hyphæ erect, cylindrical, upward slightly more slender, continuous, 120–200μ high, hyaline, ending singly in sporangia; sporangia globose, 12–15μ in diameter, smooth, membrane hyaline; spores globose, smooth, solitary, almost hyaline, in mass very dilute pale yellow, 2–5μ in diameter; chlamydospores submerged in medium, spherical to elliptical, smooth, hyaline, membrane thin.

Hab. Isolated from humous soil from Spanderswoud near Bussum, Holland, March, 1901, Koning.

Differs from *M. simplici* in the color of the colonies when in state of active growth; in color and dimensions of spores (2–5 against 10μ), also in their enucleate condition.

Mortierella humicola Oud., Contrib. Fl. Myc. des Pays-Bas ser. 2, **19**: 875. 1901; Arch. Néerl. Sci. Nat. ser. 2, **7**: 276. *pl. 1, figs. 1–3.* 1902. Lendner, Les Mucorinées de la Suisse, 56. 1908.

Colonies orbicular, nonlamellate, constantly snow-white; vegetative hyphæ dichotomously branched, hyaline, continuous, everywhere with swellings, with protoplasm full of small granules; fertile hyphæ perfectly cylindrical that is, not thickened toward the base nor attenuate toward the top, with protoplasm greatly vacuolated, 110–150μ high, unbranched and ending singly in sporangia; sporangia globose, 20μ in diameter, smooth, membrane hyaline; spores globose, smooth, up to 3μ in diameter, hyaline, from variously nucleate to not at all guttulate.

Hab. Isolated from humous soil from Spanderswoud near Bussum, Holland, March, 1901, Koning.

Suborder Conidiophorae

Family Chaetocladiaceae

Cunninghamella elegans Lendner, Bul. Herb. Boissier ser. 2, **5**: —. 1905; Les Mucorinées de la Suisse, 159–161. *figs. 58–59.* 1908.

Mycelium white (very slightly ashen), of two kinds: the first, in contact with the substratum, is very compact and in old cultures it forms a cartilaginous layer in which it takes on a pseudo-parenchymatous appearance; the other part, the aerial, is cottony; conidiophores erect, dichotomously branched, with or without septa; apex of conidiophore terminating in a very regular head; head round or slightly oval or pyriform, measuring as much as 60μ in diameter, minutely verrucose. Below the terminal head is a branch or verticil of branches of variable number, each terminated by a round head of mean diameter 18–20μ; conidia variable in size and shape; those of the terminal head being larger, ovoid, minutely verrucose, 16 by 12–14μ (maximum 14 by 22μ); those of the lateral heads smaller and more globular, 8–10μ in diameter, in color very pale blue ashen, falling easily at maturity.

Hab. From garden soil near Geneva, Switzerland, and Vuache, Savoie, Lendner.

Family Saprolegniaceae

Aphanomyces laevis de Bary, Jahrb. Wiss. Bot. **2**: 179. 1860. Fischer, Rab. Krypt. Flora Abt. 4, **1**: 358. 1892. Humphrey, J. E., The Saprolegniaceae of the United States with Notes on Other Species. Trans. Amer. Phil. Soc. Philadelphia **17**: 128–129. 1892.

Colonies thick, up to 1 cm. broad, very tender and inconspicuous, with long, unbranched, very weak and thin chief branches, which are only 5–7μ thick. Zoosporangia terminal, thread-like, often very long (up to 2 mm.), containing only one row of swarm spores (20–100, mostly 100, swarm spores), never or only seldom renewed by proliferation after the liberation of the swarm spores. Swarm spores relatively large, up to 20μ long. Oogonia terminal on short lateral branches, globular, 25–35μ in diameter, with entirely smooth membrane. Antheridia abundantly developed on all oogonia, large clavate-cylindric, on short branches of androgynous or diclinous origin, sometimes even from the oogonial branch; oospores single, globular, concentric, 20–22μ in diameter.

Hab. Soil saprophyte, parasite on beet (Busse, Peters, Ulrich) and on decaying insects in water.

Pythium de Baryanum Hesse, Inaug. Diss. Halle. *pls. 1–2.* 1874. Butler, Mem. Dept. Agr. India No. 5, **1**: 86–91. 1907.

Mycelium rather coarse, intra- and extramatrical. Hyphæ large, branching irregular and free, septate in old cultures. Sporangia spherical or oval, chiefly extramatrical, terminal and intercalary; supporting hyphæ usually emptied of their contents for a variable distance below the sporangium, and separated by septa from the full part of the hyphæ and from the sporangium. Tube of discharge lateral, about the diameter of the sporangium in length. Proliferation is absent; conidia usually numerous, intra- and extramatrical, 15–25μ in diameter, round oval, or somewhat irregular in shape and size in old cultures, may germinate at once but more usually do so after a short rest if transferred into fresh water. Oogonia usually numerous, intra- and extramatrical, sometimes formed very early in culture, 20–25μ in diameter, spherical, terminal or intercalary. Antheridia up to 3 in number, from the same or another hypha as the oogonium, often formed close below the latter and not seldom hypogonal. Oospores 14–18μ in diameter, not filling the oogonium, spherical, smooth, germinating after a rest of some months by a branching hypha.

Hab. Saprophytic in soil, Europe, United States, Butler; Europe, Busse, Peters, and Ulrich. Parasitic on a number of seedling phanerogams and on prothallia of ferns and Equisetum, Europe, United States.

Pythium intermedium de Bary, Bot. Ztg. **39**: 554. *pl. 5, figs. 14–16.* 1881. Butler, Mem. Dept. Agr. India No. 5, **1**: 6 and 96–99. 1907.

Syn. *Artotrogus intermedius* (de Bary) Atk., New York (Cornell) Agr. Expt. Sta. Bul. 94: 247. *pl. 2, figs. 10–25.* 1895.

Mycelium extra- and intramatrical, forming a regular fine haze around the substratum in water culture. Hyphæ very numerous, up to 6μ thick, regular, without intercalary swellings; branching often at right angles, sometimes dichotomous, more usually lateral. In old cultures septa, with a distinct double contour, are not uncommon. The tips of all free branches usually end in spores. They measure 18–24μ in diameter and are normally arranged in chains. When ripe they fall off readily and can germinate immediately in fresh water. (For manner of formation and position of spores see Butler.) Spores in the chain spherical or pear-shaped. These may germinate as sporangia or as conidia. In young cultures, large numbers of sporangia occur and discharge zoospores on addition of fresh water. In older ones the conidia are the organs chiefly found. The tube of discharge is always short, about one half the diameter of the sporangium. The conidia are often provided with thick walls, showing a distinct double contour Sexual organs have not been observed.

Hab. Saprophytic in garden soil, Cork, Kew, Great Britain; Paris, Antibes, France; and Freiburg i. Br., Germany, Butler. Parasitic in prothallia of Equisetum, Todea, and Ceratopteris, Germany. Parasitic in fern prothallia (not further specified). Cornell University, New York State, U. S. A., Atkinson.

Pythium vexans de Bary, Jour. Bot. **5**: 119. 1876; Jour. Roy. Agr. Soc. England ser. 2, **7**: 339. *fig. 6.* 1876; Bot. Ztg. **39**: 537. *pl. 5, figs. 3–7.* 1881. Butler, Mem. Dept. Agr. India No. 5, **1**: 91–94. *pl. 5, figs. 1–10.* 1907.

The mycelium is slender, finer than that of *P. de Baryanum* Hesse or *P. rostratum* Butler, but resembling *P. intermedium* de Bary both in the thickness of the hyphæ and the size of the thallus in water cultures. The branches of the secondary or tertiary order often extend far beyond the primary hyphæ, tapering into very fine filaments at the ends. This character distinguishes this species from all others.

Sporangia and conidia are developed on two- or three-days-old cultures. The former are rare. They occur both terminally and, more rarely, intercalarily, and are scarcely ever spherical or oval, but usually irregularly pear-shaped ovoid or subangular. The sporangial tube of discharge is short, and the zoospores are given only when the sporangia are sown immediately in fresh water. The sporangia and the conidia measure 17–24μ in diameter, averaging about 21μ. A second conidium is sometimes budded off from the first by a continuation of growth before the first is cut off by its basal septum. There are irregular intercalary swellings from which one or more branches arise.

The oogonia are 22–25μ in diameter. They arise laterally usually on short branches from the main hyphæ, or sessile on the latter. The oogonium is usually inserted on its stalk by a broad base. The antheridia usually arise from the oogonial stalk and are sometimes hypogonal. The antheridial cell is club-shaped or rounded, and large in relation to the oogonium. Oospores free in the oogonium, 20–22μ in diameter, smooth, round.

Hab. Saprophytic in garden soil, Cork, Kew, Great Britain; Antibes, France, Butler. Saprophytic in potatoes, Germany, de Bary.

Pythium proliferum de Bary, Jahrb. Wiss. Bot. **2**: 182. *pl. 21.* 1860. Ward, H. M., Quart. Jour. Mic. Sci. n.s. **22**: 497. *pls. 34 35, figs. 11–21.* 1893. Dangeard, Recherches histologiques sur les Champignons. Le Botaniste **2**: 123. *pl. 6, figs. 39–48.* 1890. Butler, The Genus Pythium and Some Chytridiaceae. Mem. Dept. Agr. India No. 5, **1**: 76–77. *pls. 3–4, fig. 1.* 1907.

Mycelium, in water cultures, fine. Hyphæ uniform, 4–5μ broad, branching lateral and sporulating in young cultures; sporangia terminal, spherical, rarely oval, vacuolated, very variable in size, 30–58μ in diameter, with short tube of discharge, rarely equaling one fourth of the diameter of the sporangium, placed in any position but usually opposite the stalk. After discharge, growth of the supporting hyphæ occurs through the emptied sporangium or immediately below it laterally, new sporangia being formed within the empty sporangium, or beyond it, in the first case. Zoospores large, 3 to numerous; conidia unknown; oogonia within and outside the substratum, terminal or often intercalary, 19–36μ in diameter. Antheridia 1–3 or more from neighboring branches and less frequently from the oogonial stalk. Oospores spherical, 16–27μ in diameter. Germination by a hypha after a rest of several months.

Hab. Found on dead insects in water and on vegetable debris in the soil, Antibes, Calcutta, Dehra Dun, Butler.

Pythium rostratum Butler, Mem. Dept. Agr. India No. 5, **1**: 84–86. *pl. 5, figs. 11–22.* 1907.

Mycelium in water cultures is large, often measuring 6 or even 8μ in diameter, tapering gradually at the ends, but never prolonged into fine filaments, with branches irregularly racemose. Sporangia either terminal or intercalary, being almost regularly spherical in the former case but often oval in the latter, average 28μ in diameter, ranging from 23 to 34μ. Zoospores are normally liberated while the sporangium remains attached to its bearing hypha. The tube of discharge is very large and broad, usually about equal to the diameter of the sporangium, usually lateral in position. Conidia are rarely as frequent as sporangia, and appear usually lateral. They resemble sporangia in all respects except the mode of germination. Oogonia intercalary or lateral, formed extramatrically, 21μ in transveres diameter and rather more longitudinally. Antheridium generally single and usually arises from the hypha bearing the oogonium, sometimes reduced to a hypogonal cell or a short lateral process arising from a cell cut off immediately below the oogonium; the cell and process together forming the antheridium. Oospores spherical, smooth, average 21μ, extremes 12 to 26μ.

Hab. Saprophytic in garden soil, Antibes, France, Butler.

Pythium monospermum Pringsh., Jahrb. Wiss. Bot. **1**: 288. *pl. 21, figs. 2–16.* 1858. Butler, Mem. Dept. Agr. India No. 5, **1**: 71–73. *pl. 2, fig. 2.* 1907. (See Butler for synonymy and further references.)

Mycelium forming a cloud around the substratum. Hyphæ irregularly branched, up to 7μ in diameter, often with numerous bud-like outgrowths laterally. Sporangia single or branched, zoospores from a few to 40 or more. Oogonia within and outside the substratum, terminal or intercalary or formed in the lateral buds. Antheridia one or more, club-shaped, arising from the oogonial or from a distinct hypha. Oospore smooth, completely filling the oogonium, 12–15μ in diameter. Germination takes place after a period of rest.

Hab. Saprophytic in soil, Cork, Great Britain, Butler; on insects in water, Germany, Pringsheim, de Bary; Wahrlich, England, Ward; France, Dangeard.

Species of Ascomycetes

Yeasts. Adametz found a red and a white yeast. These are described extensively by him. Adametz, Leopold. Untersuch. ü. d. niederen Pilze der Ackerkrume. Inaug. Diss., 39–49. 1886.

Saccharomyces glutinus Fres. Adametz, Untersuch. ü. d. niederen Pilze der Ackerkrume. Inaug. Diss. 1886.

On peptone gelatin forms rose-red colonies at 10–12° C. after 9 days, white at 17–18° C. in 4 days; colonies about 0.5 mm. high and 2 mm. in diameter; mostly round, at first having a slimy appearance, later this is lost. No liquefaction of gelatin occurs, grows as well on solid as in fluid media, irrespective of acid or alkaline reaction. Under the microscope the cells are colorless, partly single, partly two or three connected, globose or oval, 3–5μ in diameter, surrounded by a bright membrane; contents granular, sometimes with a central or sometimes with a peripheral vacuole, in which in the greater number of cases the characteristic red shimmer is to be seen without much heating.

In 10 per cent sugar nutrient solution with temperature of 20–25° C. no fermentation is produced even after the course of 3–4 weeks. Reddish sediment is produced. The solution above becomes cloudy. Inverts cane sugar. (Description after Adametz.)

Hab. Isolated from sandy and loamy soil, Germany, Adametz.

Hansenia apiculata Lendner. Kohl, F. G., Die Hefepilze, 273–276. *figs. 36–37.* 1908.

Syn. *Saccharomyces apiculatus* Rees.

Cells usually lemon-shaped. If the nutrimental relations are unfavorable, ovate or elongated cells dominate. Spore formation is unknown. It does not ferment maltose nor invert saccharose. In yeast water with 10 per cent dextrose gives 4.3 per cent alcohol.

Hab. Isolated from soil, Germany, Müller-Thurgau.

Saccharomycopsis capsularis Schönning. Kohl, F. G., Die Hefepilze, 279. *fig. 40.* 1908.

Cells ovate or sausage-shaped. Typical mycelium formation with septa; cardinal points of budding, minimum under 5° C., optimum 25–28° C., maximum 38.2° C. Develops quickly a white, uneven, felt-like mat (kahmhaut) on the culture fluid; on solid media it forms a more or less uneven white and felty growth; on wort-gelatin it takes on a chocolate-brown coloration after long standing. Characteristic is the velvet-like appearance of the culture on solid media. This is brought about by the numerous hyphæ arising together to form coremia, on whose tips the budding cells become separated.

Spores depressed globose, 3.5–8μ in diameter, mostly four in a cell; with germination the exospore opens with usually two unequally great valves, which remain connected and often remain attached to the spore for a long time. The exospore with sulfuric and several other mineral acids takes on a rose coloration. Cardinal points for sporulation, minimum 5–8° C., optimum 25–28° C., maximum 34.5–35° C. The spores possess a great resistance even against concentrated sulfuric acid. The yeast ferments dextrose, fructose, galactose, and maltose, not, however, saccharose and lactose.

Hab. Found in the soil of a grass field in the northern Alps, Switzerland. Kohl, l. c.

Willia saturnus Klöcker. Kohl, F. G., Die Hefepilze, 285. *fig. 43*. 1908.
Syn. *Saccharomyces saturnus* Klöcker.

Cells globose or ellipsoidal, seldom elongated, mostly 4–6μ long. The rapidly appearing mold membrane (kahmhaut) is white and wrinkled. The temperature limits for budding are, minimum 2–4° C., maximum 35–37° C. Spores are more or less regularly lemon-shaped, with a border from tip to tip, which resembles a picture of Saturn — hence the name *saturnus* — about 3μ long, with a strong refrangible globose body in the center. Cardinal points for sporulation, minimum 4–7° C., optimum on gypsum block 25° C., maximum 28–31° C. Ferments dextrose, fructose, raffinose, and saccharose; does not ferment maltose and lactose.

Hab. Found in the soil of the Himalaya Mountains, also later this species or a very closely related species was found in Denmark and in Italy. Kohl, l. c., 285. No mention is made as to who found the species in the soil.

Willia anomala Hansen. Kohl, F. G., Die Hefepilze, 284. *fig. 42*. 1908.
Syn. *Saccharomyces anomala* Hansen.

Cells small, oval, occasionally elongated, external morphology resembles Torula more than Saccharomyces, vacuolate, with vacuole granules. Nucleus relatively small, 0.8μ. Nuclear membrane visible. In the course of development glycogen vacuoles arise either in the middle of the cell or at each pole. In beer wort, fermentation begins soon after inoculation as well with ordinary temperature as at 25° C. In the beginning of fermentation there is produced a matty gray mold-like membrane (kahmhaut). During fermentation the fluid becomes turbid and a plain odor of fruit ether is manifest. The temperature limits of budding are, 0.5–1° C. minimum, 37–38° C. maximum.

The spores are hat-like, with projecting borders on the edge of the base, diameter without border 2–3μ; spores 2–4 in a mother cell. On germination the spore buds directly. Cardinal points for sporulation on the gypsum block are as follows: minimum 2.5–7.5° C., optimum 30° C., maximum 32–34° C. Spores are found in the mold membrane (kahmhaut) as well as in the sediment.

Hab. Found in impure brewery yeasts in English and Belgium beers, on bran, marsh-mallow sap, in soil, on plums and other fruits.

Chaetomium olivaceum Cooke & Ellis, Grev. **4**: 96. 1876. Ellis and Everhart, North American Pyrenomycetes, 124. 1896.

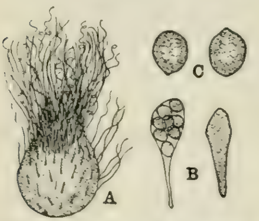

Fig. 111.—*Chaetomium olivaceum Cooke & Ellis.* A, *perithecium, x 60;* B, *mature and immature asci, x 236.6;* C, *ascospores, x 533.3*

Perithecia gregarious, ovate-globose, about 250μ high by 200μ broad, thickly and evenly clothed with soft granular roughened, flexuose, sparingly septate, simple greenish yellow hairs 3–4μ thick, without any very distinct apical tuft of coarser hairs, as is usual in most of the species. Asci oblong clavate p.sp. 35–40 by 12μ. Sporidia crowded, globose, elliptical, apiculate at each end, yellowish brown, 9–12 by 8–9μ (mostly 9–11 by 7–8μ), with one or more guttulæ.

Hab. Isolated from oat field in July, 1910, near the College of Agriculture, Cornell University, Ithaca, N. Y., by the writer. Plant pathology herbarium No. 5,905.

Pleurage verruculosis n. sp.

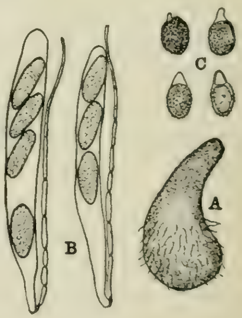

Fig. 112.—*Pleurage verruculosis.* A, *perithecium, x 60;* B, *asci, showing immature spores and paraphyses, x 236.6;* C, *stages in maturation of ascospores, x 236.6*

Perithecia scattered or aggregated, sunken but becoming partly to entirely exposed at maturity, membranaceous to carbonaceous, black, opaque, 350–750 by 225–375μ, pyriform to subglobose, with straight or curved beak.

Asci 4-spored, cylindrical, broadly rounded at apex and tapering below into a slender stipe, perforate, 90–150 by 11–16μ; paraphyses filiform, slightly tapering upward, longer than the asci, septate to articulate.

Spores vertically uniseriate, long ovate when young to subglobose at maturity, obtusely pointed above and broadly rounded to truncate below, germ pore prominent, strongly tuberculate, ranging in color from hyaline when young through brown to black at maturity, 12–14 by 16–18μ, primary appendage 6 to 8μ and conic shortly after migration of protoplasm from below is completed and the septum is formed, at full maturity it becomes a shrunken hyaline appendage of 3–4μ in length; secondary appendages entirely wanting.

Hab. Soil from oat field July and August, 1910, Cornell University, Ithaca, N. Y., by the writer. Plant pathology herbarium No. 5,906.

Peritheciis sparsis vel gregariis, pyriformis-subglobosis, immersis demum subliberis vel liberis, membranaceis-coriaceis, atris, opacis, ostiolo conico, recto, vel parum curvato; ascis 4-cellularibis, cylindraceis, apice rotundatis, basim versus sensim attenuatis, perforatis, 90–150 x 11–16μ, paraphysibus ascos superantibus, filiformis, sursum attenuatis, articulatis; sporidiis uniseriatis, elongato-ovatis demum subglobosis, 1-nucleatis, tuberculatis, atrofuscis, 12–14 x 16–18μ, candaque conica saepe curvula hyalina 6–8μ long.

Hab. In campus arabilis, Ithaca, N. Y.

Differs from other species of the genus in the perforate ascus and the lack of secondary appendages. Distinctive characters: 4 spores, perforate ascus; spores tuberculate with primary appendages only.

It is to be observed that this species is placed in the genus Pleurage rather than to form a new genus. This species has been cultivated for over one year on nutrient agar, soil solution agar, and straw plugs, and the above characters are found to be constant.

The formation and development of the spores has been carefully studied. In all cases the primary appendage is formed as given by Griffiths (The North American Sordariaceae, 21. 1901). Iodin and eosin stains have been used to locate secondary appendages in alcoholic and aqueous mounts, but these have never been seen.

Sporormia fasciculata n. sp.

Perithecia scattered or aggregated in small clusters, sunken, with small papilliform beak projecting to the surface, later many become partly exposed, globose, thin membranaceous, inclined to be brittle, black, opaque, 250–525μ in diameter.

Asci 8-spored, broad clavate, broadly rounding above and rapidly contracting just below spores to form a long slender stipe, 45–60 by 16–30μ; stipe about two fifths the length of the ascus; paraphyses absent.

Sporidia fasciculate, straight or very slightly curved, 4-celled, rounded at both ends, deeply constricted and easily separating, 25–30 by 4–7μ, ranging in color from hyaline when young through light brown to dark brown, opaque.

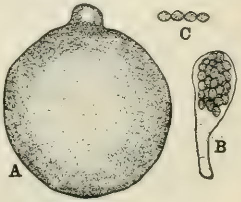

FIG. 113.—*Sporormia fasciculata.* A, *perithecium, x 60;* B, *ascus, showing fasciculate arrangement of ascospores, x 236.6;* C, *ascospores, x 236.6*

Distinctive characters: large perithecia, spores fasciculate, paraphyses wanting.

Hab. Isolated from oat field soil, July, 1910, Cornell University, Ithaca, N. Y., by the writer. Plant pathology herbarium No. 5,907.

Peritheciis sparsis vel cæspitosis, immersis, demum saepe subliberis, membranaceo-molliculis, fragilibus, atris, opacis, 250–525μ diameter; ostiolo papillulato, exserto; ascis octosporis, lato-clavatis, apice rotundatis, stipite elongato gracile, 45–60 x 16–30μ; stipite 30–40μ long, sine paraphysibus; sporidiis fasciculatis, rectis vel parum curvatis, 3-septatis, curvulis utrinque, constrictis alte ad septum, facile secedentibus, initio hyalinis, demum atrofuscis, opacis.

Hab. In humis, Ithaca, N. Y., Amer. bor.

Differs from S. *minima* in size and shape of ascus, larger perithecium, and fasciculate spores; from S. *chrysospora* in larger perithecium, in size of ascus, and in smaller spores arranged in fasciculate fashion.

This fungus has been grown continuously for over one year on nutrient agar, soil solution agar, and straw plugs, without variation. Attempts have been made repeatedly to find paraphyses in young material by staining with iodin and eosin. None have been found.

Species of Fungi Imperfecti

Sphaeropsidales

Chaetomella horrida Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 280–281. *pl.* 7, *fig.* 2. 1902.

Mycelium creeping, from white to darkish, branched, septate; pycnidia 180 by 140μ, superficial, scattered, ovate, without ostiole, brown (Sacc. Chromot. No. 9), in transmitted light dark brown, with setæ on all sides; setæ of the old pycnidia rising high, downward black and opaque, upward lighter, dark or dilute olive, septate, when young smooth, when old slightly roughened, once or many times dichotomously branched, ultimate branches awl-shaped; spores broad elliptical, biconvex, commonly apiculate on both ends, very dilute steel-colored, 5.5–7 by 3.5–4μ; basidia toward the base dark, above hyaline, three times length of spores.

Hab. Isolated from a piece of birch from humous soil of the wood called Spanderswoud, near Bussum, Holland, May 12, 1901, Koning.

Apparently this species is near *Ch. furcata* Cooke & Massee, Grev. **17**: 43. 1888; Sacc. Syll. Fung. **10**: 270. The species differs by its ovoid, brown perithecia, by the apiculate, pale steel-colored, and much smaller spores (5.5–7 by 3.5–4μ as compared with 10–11 by 8μ).

Chaetomella tortilis Delacroix, Bul. Soc. Myc. France **7**: 106. 1891. Sacc. Syll. Fung. **10**: 272. 1891.

Pycnidia without ostioles, nearly semiglobose, gregarious, covered with setæ, 140–160μ in diameter; setæ tortuous, often curved to form hooks, blunt, smooth, simple, septate, olive-brown, 300–350 by 4.5–5μ; spores partly lemon-like, partly cymbiform, apiculate at both ends, at first pale violet or steel-blue, finally dark violet or black, 10–12 by 6–6.5μ; basidia short, relatively thick, pale brown, either solitary or united in chaplets for the support of the spores.

Hab. Isolated from piece of birch found in the humous soil of the woods called Spanderswoud near Bussum, Holland, May, 1901, Koning.

Sphaeronema Fagi Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 281. *pl. 9, fig. 1.* 1902.

Pycnidia spherical, loosely surrounded by dark hairs, black, opaque, 92–140μ in diameter, neck hollow, cylindrical, black, opaque, attenuate upward, formed from very thin dark hyphæ 500–540μ high, base 23μ, summit 7.6μ in diameter; glebula of conidia hyaline, elliptical, 3–4 by 2μ. After the liberation of the spores there remain very slender penicillium-like filaments at the summit of the neck.

Hab. Isolated from the decaying leaves of *Fagus sylvatica* from the humous soil of Spanderswoud near Bussum, Holland, May, 1901, Koning.

Hyphomycetes

Mucedinaceae

Sachsia albicans C. Bay, Sachsia ein neues Genus der Hefenähnlichen, nicht Sporentragenden, Pilze. Ber. Deut. Bot. Gesell. **12**: 90–93. *fig.* —. 1894.

Colony orbicular, dense, snow-white, raised, margin irregular, deeply crenate; mycelium hyaline, submerged and aerial; submerged mycelium consisting of yeast-like cells usually swollen at both ends, constricted in the middle, occasionally pyriform, guttulate; guttulæ throughout the cell 7–15 by 2–8μ. Aerial hyphæ 26–86μ long by 2–4μ thick, often irregular in diameter, gradually attenuate toward tip, guttulate, with yeast-like cells toward base.

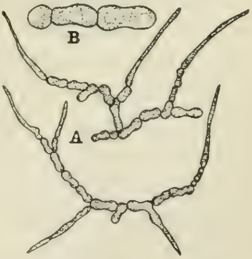

Fig. 114.—*Sachsia albicans C. Bay.* A, *hyphæ, showing method of development and branching, x 236.6;* B, *segments of hypha enlarged, x 533.3*

The original states that the mycelium gives off round, oval, or pyriform spores, similar to Mycoderma but distinguished from this genus in that short mycelial threads arise from the cells or spores. Size of these spores is 0.6–4 by 0.5–3μ. The author further states that he had a culture which produced no spores and no such aggregations as described. Our culture so far has not been observed to produce the spores. The author gives dimensions of yeast-like cells as 10–20μ long by 2–10μ in diameter, and aerial hyphæ 50–200μ long by 2–10μ wide. Our form, as already observed, does not quite agree with these measurements.

Hab. Isolated from soil of oat field, July, 1910, Cornell University, Ithaca, N. Y., by the writer.

Actinomyces No. 1076b Hagem, Einige Beobachtungen über die Verbreitung der Actinomycetes in der Natur. Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 202. 1910.

Macroscopic appearance, only, is given and is as follows: Grows well at ordinary room temperature. Isolated from same soil and same sample as 1076a. It is distinguished from this by its dark gray colonies, with zonate aerial mycelium that is of a gray-white or frequently reddish white color.

Hab. Isolated from forest soil, Norway, Hagem.

Actinomyces No. 1076a Hagem, Einige Beobachtungen über die Verbreitung der Actinomycetes in der Natur. Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 202. 1910.

Macroscopic appearance, only, is given and is as follows: Thrives rather well on wort-agar and at ordinary room temperature. The colonies are dirty wax-yellow and strongly folded, or plaited. Aerial mycelium does not form.

Hab. Isolated from forest soil, Norway, Hagem.

Actinomyces No. 1075 Hagem, Einige Beobachtungen über die Verbreitung der Actinomycetes in der Natur. Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 202. 1910.

Macroscopic appearance, only, is given and is as follows: Grows very well on wort-agar and only with ordinary temperature relations (ordinary room temperature or up to 20–25° C.). The colonies form great masses of dirty-gray aerial mycelium. Thrives well on filter paper to which has been added ammonium phosphate and inorganic nutrient salts. Digests and uses the cellulose of the filter paper.

Hab. Isolated by A. E. Traaen from mud at the edge of a meadow (Schamm einer Uferweise). Hagem, l. c.

Actinomyces No. 1074 Hagem, Einige Beobachtungen über die Verbreitung der Actinomycetes in der Natur. Vid.-Selsk. Skr. I, Math.-Naturv. Klasse No. 7, 202. 1910.

Macroscopic appearance, only, is given and is as follows: Grows very well on ordinary wort-agar (würzagar). The colonies are somewhat plaited, or folded, and form rich masses of gray-white aerial mycelium. This fungus thrives well at ordinary room temperature, and at blood heat germinates but poorly.

Hab. Isolated twice from forest soil, Norway, Hagem.

Oospora lactis (Fres.) Sacc., Syll. Fung. **4**:15. For synonymy and bibliography see Sacc. Syll. Fung. **20**: 233. 1911. (Compare Lindau, Rab. Krypt. Flora Abt. 8, **1**: 32. 1904–1907.)

Colonies far-spreading, membranaceous, velvety, pure white, often becoming a thick covering over substratum; hyphæ simple or branched, creeping or somewhat ascending, hyaline, of variable length and breadth, mostly 6–12μ broad, breaking up into irregular pieces that are to be considered as spores; spores cylindrical to ovate, often also globose, or somewhat irregular in form, mostly 6–20μ long.

Hab. Isolated from garden soil, Copenhagen, Hansen; Germany, Adametz.

Monilia humicola Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 286. *pl. 20, figs. 1–4.* 1902. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 60. 1904–1907.

Colonies orbicular, dense, at first nearly hyaline, later entirely green; sterile hyphæ creeping, when young hyaline, consisting of alternating longer and shorter cells with granular protoplasm, when old green, consisting of cylindrical cells of equal length with homogenous protoplasm; conidiophores ascending or erect, yellow or green, closely septate, divided into cylindrical articulate cells that readily separate from each other, branched; branches alternate or nearly opposite, once or twice dichotomously divided; conidia in short chains, immature subglobose, mature ellipsoidal, both ends apiculate, greenish, 4–10 by 2–5μ.

Hab. Isolated on gelatin from pulverized humous soil from woods called Spanderswoud near Bussum, Holland, March, 1901, Koning.

Monilia fimicola Cost. et Matr., Rev. Gén. Bot. **6**: 292. *pl. 13, figs. 9–13.* 1894. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 55. 1904–1907.

Colonies far-spreading, powdery, white, occasionally with reddish glimmer, becoming gray with age; hyphæ hyaline, septate, little branched, 2–5μ thick; conidiophore branches 4–5 together, arising from the hyphæ in widely separated groups, irregularly branched, 50–100μ long, sparsely septate, last branches of conidiophores which carry the conidial chains almost constantly about 25μ long, at the tip somewhat attenuated and breaking up into conidial chains; conidia ellipsoidal, both ends somewhat flattened at first, later rounded, hyaline, 6.5–8μ long and 4.5–5.3μ broad.

Hab. On mushroom beds, manure, straw, soil, and the like, in Paris. (Lindau, l. c.) No mention is made as to who found it on soil.

Monilia geophila Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 286. *pl. 19, fig. 1.* 1902. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 56. 1904–1907.

Colonies composed of loosely intertwined hyphæ, yellowish white or ocher-yellow (Sacc. Chromot. 28 and 29); vegetative hyphæ creeping, branched, sparsely septate, fertile hyphæ ascending or erect, closely septate, toward the top either once or twice forked or irregularly branched;

branches few and short; chains of conidia one or two, emerging from the tip of the branch; conidia at first subglobose, afterward elliptical, pale yellow, 3–5 by 2–3μ.

Hab. Isolated on gelatin from pulverized humous soil from woods called Spanderswoud near Bussum, Holland, March, 1901, Koning.

Monilia Koningi Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 287. *pl. 21, figs. 1–4.* 1902. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 59. 1904–1907.

Colonies orbicular, subzonate, brownish rose; vegetative hyphæ hyaline, 4–5μ thick, septate, dichotomously branched; conidiophores racemosely branched; branches basidia-like, 30–40μ long, terminating in single conidial chains; conidia as many as 20 in a chain, subglobose, apiculate at superior end, smooth, 6–8μ in diameter, brownish rose.

Hab. Isolated on gelatin from pulverized humous soil from woods called Spanderswoud near Bussum, Holland, April, 1901, Koning.

Monilia acremonium Delacr., Bul. Soc. Myc. France **13**: 114. *pl. 9, fig. C.* 1897. Sacc. Syll. Fung. **14**: 1041. 1899. Oudemans, Arch. Néerl. Sci. Nat. ser. 2, **7**: 285. *pl. 18, fig. 1.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 903. 1903. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 55. 1904–1907.

Colonies snow-white, slightly floccose; sterile hyphæ creeping, hyaline, sparsely white, with oil drops, 4–5μ thick; conidiophores ascending or erect, ordinarily united in bundles or even twisted, septate, divided above into one or more layers of forked branches, all terminated by chains of numerous conidia; conidia ovate-pyriform, on the base somewhat truncate, at tip ending in a round point, 12–15 by 8–10μ, hyaline.

Hab. On decaying paper in a laboratory in Paris, Delacroix; isolated from humous soil from the woods called Spanderswoud near Bussum, Holland, May, 1901, Koning.

Monilia candida Bonord., Handb. Allg. Myk., 76. *fig.* 86. 1851. Sacc. Fung. Ital. *pl. 851.* 1881; Syll. Fung. **4**: 32. 1886. Adametz, Untersuch. ü. d. niederen Pilze der Ackerkrume, 36–39. 1886.

The form of the cells depends on the chemical composition, the reaction, and the state of aggregation of the substratum; for example, on peptone gelatin the fungus produces predominantly long septate hyphæ, while on pieces of apple, yeast cells and short hyphal forms in almost similar amounts arise. Practically, only round yeast cells containing 2–3 vacuoles are produced in 10 per cent cane sugar solution, and these remain connected in chains or clusters. In general, on solid sugar-free and neutral or alkaline nutrient media, the tendency to form long cells predominates, while in fluid, sugar-rich, weak-acid nutrient media, the specific yeast character of round cells is predominant. On gelatin streaks short hyphæ with septa are formed, as well as elliptical to cylindrical cells. The latter are 4–5.5μ broad by 5–10μ long, the former (hyphæ) are of different lengths, with a width of 5–8μ.

In a solution of requisite ash salts plus 0.5 per cent ammonium tartrate and 10 per cent cane sugar, test was made for inversion of the sugar. Inversion took place. The yeast cells forming the membrane in this solution were round, 6–8μ in diameter. Sediment consisted of different-length hyphal forms. (Description after Adametz.)

Hab. Sandy and loamy soil, Germany, Adametz.

Geotrichum candidum Link, Mag. Gesell. Naturf. Fr. Berlin **3**: 17. *pl. 1, fig. 26.* 1809. Sacc. Fung. Ital. *pl. 790.* 1881; Syll. Fung. **4**: 39. 1886. Lindau, Rab. Krypt. Flora Abt. 8, **7**: 76. 1904–1907.

Syn. *Acrosporium candidum* Spreng., Syst. **4**: 556. 1827.
Botrytis geotricha Link, Spec. Plant. **1**: 53. 1824.
Torula geotricha Corda, Sturm D. Fl. Pilze **2**: 73. *pl. 33.* 1828.
Sporotrichum laxum Mart., Fl. Erlang., 335. 1817.

Colonies cushion-like, somewhat powdery, white; hyphæ creeping, sparsely septate; conidiophores erect, short; conidia in chains, short cylindrical, truncate at both ends, 5–10μ long, 4μ broad, hyaline.

Hab. On barren soil, on bones and decaying paper, Germany, Lower Austria, Italy, and France, in summer and autumn. See Lindau, l. c., for statement that fungus grows on barren soil.

Cephalosporium acremonium Corda, Icon. Fung. **3**: 11. *pl. 2, fig. 29.* 1839. Fresenius, Beitr. **3**: 94. *pl. 11, figs. 59–63.* 1863. Sacc. Fung. Ital. *pl. 706.* 1881; Sacc. Syll. Fung. **4**: 56. 1886. Lindau, Verh. Bot. Ver. Brandenb. **45**: 158. 1903; Rab. Krypt. Flora Abt. 8, **1**: 103. 1904–1907. Oudemans, Arch. Néerl. Sci. Nat. ser. 2, **7**: 284. *pl. 15, fig. 1.* 1902.

Colonies orbicular, dense, floccose, at first white, later very light rose-colored; vegetative hyphæ hyaline, sparsely septate, branched, very thin (2.5–3μ thick); conidiophores erect, simple, arising as side branches from vegetative hyphæ, unseptate, 40–60 by 3μ; conidia numerous, elliptical or oblong, straight or curved, nearly hyaline, 4 by 1–1.5μ, borne singly at the apex of the conidiophore, but pressed to the side by the next produced and adhering by means of slime, eventually resulting in a capitule, 14–16μ in diameter and of very dilute rose-color.

Hab. Isolated from humous soil, Holland, Koning.

Cephalosporium humicola Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 285. *pl. 16, fig. 1.* 1902. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 108. 1907.

Colonies orbicular, floccose, at first white, later with white margin and dilute rose-colored center; sterile hyphæ branched, septate, hyaline, 3–5μ thick, intermixed with thicker, irregular segments of septate hyphæ whose cells appear very much as chlamydospores; conidiophores erect, thin, 100–200μ high, unbranched, nonseptate, at the tip with a globose, 20–26μ-in-diameter capitule of a very dilute rose-color; conidia conglutinate, globose, 2.3–2.5μ in diameter, almost hyaline.

Hab. Isolated from pulverized humous soil from the woods called Spanderswoud near Bussum, Holland, March, 1901, Koning.

Cephalosporium Koningi Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 285. *pl. 17, fig. 1.* 1902. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 108. 1904–1907. Colonies white; sterile hyphæ creeping, branched, hyaline, nonseptate, with intercalary globose or fusiform chlamydospores; chlamydospores with foamy protoplasm, 12–15 by 6–12.5μ; conidiophores erect, continuous, with smoky protoplasm, simple or branched, terminating singly with a globose, 25–35μ-in-diameter glomerule of conidia that adhere closely and are destitute of a membrane; conidia globose, hyaline, continuous, 5–10μ in diameter.

Hab. Isolated on gelatin from humous soil from woods called Spanderswoud near Bussum, Holland, April, 1901, Koning.

Lindau, cited above, is of the opinion that this species belongs with the Mucoraceae on the grounds of the presence of chlamydospores, the lack of septa, and the loose coherence of the spores in the glomerule.

Trichoderma Koningi Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 291. *pl. 31, figs. 1–7.* 1902. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 111. 1907.

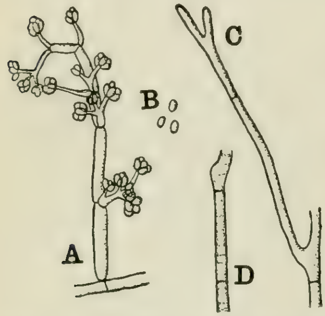

FIG. 115.—*Trichoderma Koningi Oud.* A, *sporangiophore, showing method of branching and conidial heads, x 355;* B, *spores, x 355;* C, *showing method of branching of young hypha, x 355;* D, *showing old vacuolate hypha, x 355*

Colonies orbicular, floccose, at first white, later dotted or spotted with green, finally verdigris or light olive-green; vegetative hyphæ hyaline, very sparsely septate, branched; branches alternate or opposite, each 1- or 2- or 3-forked, ultimate branches carrying the 8–10μ-in-diameter conidial head; conidia almost hyaline, ellipsoidal, 3–4μ long by 2.5–3μ wide, destitute of mucus, soon separating.

Hab. Isolated from humous soil from Spanderswoud near Bussum, Holland, June, 1901, Koning. Isolated repeatedly from soil of plant-breeding plats, Cornell University, Ithaca, N. Y., by the writer. Plant pathology herbarium No. 5,909.

Trichoderma lignorum (Tode) Harz.

Syn. *Pyrenium lignorum α vulgare* Tode, Fungi Mecklenb. **1**: 33. *pl. 3, fig. 29.* 1790.
Trichoderma lignorum Harz, Bul. Soc. Imp. Nat. Moscou, **44**: 116. *pl. 4, fig. 6.* 1871.
Mucor lignifragus Bul., Champ. *pl. 504, fig. 17.*
Botrytis lignifraga DC., Fl. France **2**: 70. 1805.
Trichoderma viride Pers., Tent. Disp. Meth. Fung., 12. 1797.
Trichoderma argenteum Pers., ined. apud Fries Syst. Myc. **3**: 215. 1829.
Trichoderma aeruginosum Link, in Mag. Gesell. Naturf. Fr. Berlin **7**: 41. 1816.
Trichoderma intermedium Desm., Pl. Crypt. fas. **3**: 122.
Sphaeria olivacea Willd., Prodr. Fl. Berol., 416. 1787. Sacc. Syll. Fung. **4**: 59. 1886. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 110. 1904–1907.

Colonies orbicular, tufted, zonate, at first pure white, then later from the center toward the periphery gradually turning light green, finally becoming darker green, occasionally yellowish green; vegetative hyphæ creeping, hyaline, septate, branched; conidiophores arising as side branches of the mycelium, ascending, nonseptate, di- or trichotomously branched; last branches clavate to lageniform, 8–10 by 2.5μ, supporting the 7–9μ-in-diameter conidial head; conidia light green, globose, 2.5–3μ in diameter.

Hab. Isolated constantly from soil about Cornell University, Ithaca, N. Y., by the writer. Plant pathology herbarium No. 5,910.

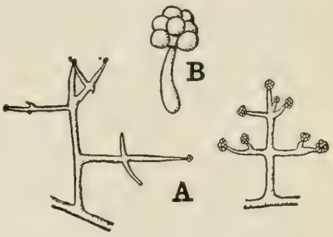

Fig. 116.—*Trichoderma lignorum* (*Tode*) *Harz.* A, *sporangiophores, x 355;* B, *part of sporangiophore with conidial head, x 800*

Corethropsis paradoxa Corda, Prachtflora, 1. *pl. 1.* 1839; Flor. Ill. Muc. Eur., 1. *pl. 1.* 1840. Sacc. Syll. Fung. **4**: 62. 1886. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 118. *figs. 1–3.* 1904–1907.

Syn. *Stachylidium paradoxum* Bonord., Handb. Allg. Myk., 110. *fig. 152.* 1851.

Hyphæ whitish, united to form ascending bundles on base of which grow forth the septate di- or trichotomous conidiophores; conidiophores swollen at the summit, with obclavate sterigmata; conidia ovate, standing singly, hyaline.

Hab. On soil near Prague, Corda.

Aspergillus fumigatus Fres., Beitr. 81. *pl. 10, figs. 1–11.* 1863. Siebenmann, Die Schimmelmykosen, 5. *pl. 1, figs. 3, 4, 6, 7.* 1889. Schroeter, Schles. Krypt. Flora Pilze **2**: 216. Sacc. Syll. Fung. **1**: 65. 1886. Wehmer, Aspergillus, 70. *pl. 1, No. 3; pl. 4, No. 3; pl. 5, fig. 2.* 1901. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 133. *fig. 1.* 1904–1907.

Colonies orbicular, at first light green, finally becoming very dark green; hyphæ creeping, branched, septate, hyaline, 1.5–6μ thick; conidiophores 200–400μ high, 3.5–6μ thick, ascending, erect, hyaline, usually unbranched, uniseptate, toward the summit enlarging into a globose swelling of 10–20μ in diameter; sterigmata cylindrical to clavate, hyaline, 6–8 by 1.5–2μ, simple, continuous; conidia broad ovate to perfectly globose, 2.5–3.5μ in diameter, smooth, catenulate, chains short.

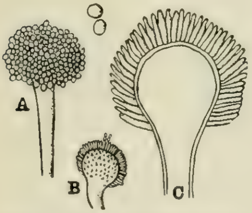

Fig. 117.—*Aspergillus fumigatus Fres.* A, *conidiophore and conidial head, x 236.6;* B, *globose swelling of conidiophore, showing sterigmata, x 236.6;* C, *optical section of globose swelling, x 533.3*

Hab. Isolated from soil of plant-breeding experimental plats, Cornell University, Ithaca, N. Y., frequently, and from roots of pepper and of corn taken from soil in spring of 1911. Plant pathology herbarium No. 5,911.

Differs from Lindau's description only in slightly smaller heads and shorter (generally) sterigmata.

Aspergillus globosus n. sp.

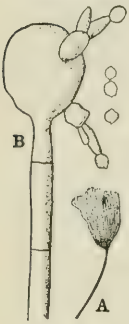

FIG. 118.—*Aspergillus globosus.* A, *conidiophore and conidial fructification, x 60;* B, *globose swelling of conidiophore, showing primary and secondary sterigmata and spores, x 533.3*

Conidiophores singly or aggregated in tufts; tufts olive-green, attaining a maximum height of 0.7 mm., and 0.4 mm. in diameter; conidiophores erect, septate, unbranched, 250–350μ high by 4.5–5.5μ thick, terminating in a subglobose to broad obovate swelling; swelling closely beset with branched sterigmata, 12–20 by 10–15μ; primary sterigmata subglobose to broadly obovate, 5–6 by 4.5–5μ, very easily separating from swelling when placed in mounts; secondary sterigmata 5–8μ long by 1.4–1.6μ broad; conidial head long obovate to cylindrical, 120–225 by 100–190μ; conidia globose, warty, tinged with green, 2–3μ in diameter, in very long chains.

Hab. Isolated from pepper root that was removed from soil from the plant-breeding experimental plats, Cornell University, Ithaca, N. Y., in March, 1911, after having remained in the soil all winter. Description made from fungus growing on sterilized straw plugs. Plant pathology herbarium No. 5,912.

Differs from *A. calyptratus* in the smaller globose swelling, in having branched sterigmata, and in having warty spores.

Conidiophoris solitariis vel cæspitosis; cæspitibus virentibus, maximo 0.7 mm. altitudine, 0.4 mm. diam. Conidiophoris erectis, septatis, simplicibus, 250–350 altitudine x 4.5–5.5μ, apice in vesiculam, subglobosam ad lato-obovatam desinentibus; vesiculis cum sterigmatibus ramosis, 12–20 x 10–15μ; sterigmatibus primariis subglobosis ad lato-obovatis 5–6 x 4.5–5μ, separabilibus facile ab vesiculis; sterigmatibus secundariis 5–8 x 1.4–1.6μ; capitibus conidialibus, longo-obovatis ad cylindricis, 120–225 x 100–190μ; conidiis globosis, tuberculosis, virentibus, 2–3μ diam., longe catenulatis.

Hab. In radicibus hiemantibus Piperacearum. Ithaca, N. Y., Amer. bor.

Differens ab *A. calyptratus* in vesiculis minoribus, sterigmatibus ramosis, et conidiis tuberculosis.

Aspergillus glaucus (L.) Link, Sacc. Syll. Fung. **19:** 118–119. 1910. For synonymy and bibliography see Lindau, Rab. Krypt. Flora Abt. 8, **1:** 125–127. 1904–1907.

Conidial tufts when young bright green to verdigris green, later becoming darker, and finally becoming gray-green to gray-brown; hyphæ hyaline, often in age yellow to brown, about 3μ thick; conidiophores erect, unbranched, 1–2 mm. high, 14μ or more thick, hyaline, beset with radiating, crowded, simple, short sterigmata that are 10–14μ long by 5–7μ thick; conidia in chains, globose or somewhat ovate, smooth, later mostly fine granular, mostly 7–10μ in diameter, maximum 15μ.

Hab. Isolated from soil, Germany, Adametz.

Aspergillus terricola March, Rev. Myc. **15**: 101. 1893. Sacc. Syll. Fung. **11**: 592. 1895. Wehmer, Aspergillus, 125. 1901. De Wild. et Dur., Prodr. Fl. Belg. **1**: 307. 1898. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 147. 1904–1907.

Sterile hyphæ creeping, hyaline, 2–5μ thick; conidiophores 7–10μ thick; swelling rough, hyaline, 30–50μ in diameter, closely beset with radiating sterigmata 12–15μ long, 4–7μ thick; conidia globose, amber-brown, very fine-spiny, separated by short hyaline isthmuses, in long chains.

Hab. In humous soil near Brussels, Belgium. See Lindau, l. c., for authority that fungus lives in humous soil.

Aspergillus calyptratus Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 283. *pl. 13, fig. 1.* 1902. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 139. 1904–1907.

Vegetative hyphæ hyaline, branched, septate; fertile hyphæ 200–300μ high, strict or subflexuose, continuous, toward base hyaline, toward top dilute green, ending in an ellipsoidal or obpyriform swelling, 20–22μ in diameter, concolorous; sterigmata very close, very numerous, cylindrical, acute, 6μ long; conidia perfectly globose, smooth, grayish, 2.3μ in diameter, in series of very long chains, which form a dark cylindrical body up to 170μ high.

Hab. Isolated from a decaying piece of oak from humous soil from Spanderswoud near Bussum, Holland, May, 1901, Koning.

Aspergillus Koningi Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 284. *pl. 14, fig. 1.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 899. 1903. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 147. 1907.

Colonies cream-colored (Sacc. Chromot. No. 27); vegetative hyphæ creeping, branched, septate, hyaline; conidiophores strict or curved, simple, nonseptate, hyaline, up to 400μ high, apex swollen to form a subglobose, smooth, hyaline sphere of 16–20μ in diameter; conidial head globose, up to 135μ in diameter; sterigmata narrow clavate, hyaline, rounding at tip, simple, nonseptate, 8–10 by 2.5μ; conidia globose, cream-colored, 3μ in diameter, smooth, catenulate.

Hab. Isolated on gelatin media from humous soil from Spanderswoud near Bussum, Holland, June, 1901, Koning. Isolated from experimental plats of Plant-Breeding Department, Cornell University, Ithaca, N. Y., September and December, 1910, and January, 1911. Plant pathology herbarium No. 5,913.

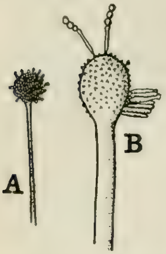

FIG. 119.—*Aspergillus Koningi Oud. A, conidiophore and conidial head, x 90; B, globose swelling of conidiophore, showing sterigmata and spores, x 355*

The original gives the conidial head as being only 85μ in diameter. It is not uncommon to find it measuring 130μ in diameter. Also, the conidiophores measure as high as 400μ. The original gives the mycelium as continuous, while it is sparsely septate.

Penicillium chrysogenum Thom, Cultural Studies of Species of Penicillium. U. S. Dept. Agr., Bur. Anim. Indus. Bul. 118: 58–60. *fig. 20.* 1910.

Cultivated in 15 per cent gelatin in distilled water, 15 per cent gelatin plus 3 per cent cane sugar in distilled water, potato decoction plus 1.5 per cent agar, potato decoction plus 3 per cent cane sugar plus 1 per cent agar, at first blue-green, becoming with age slate-gray in agar and gelatin without cane sugar, where sugar is added to gelatin or agar the colonies do not become as gray as where sugar is omitted, broadly spreading in the substratum with a wide sterile white margin when young. Reverse of colony yellow-green. Conidiophores mostly arising separately, 100–250μ high by 3–5μ thick, with 1–3 alternate diverging branches bearing once or twice verticillate branchlets. Conidiiferous cells 7–10 by 2–3μ, usually in verticils; conidia globose, 3–5.5μ in diameter. Colonies liquefy gelatin with alkaline reaction to litmus, and in gelatin and on potato plugs a lemon-yellow color.

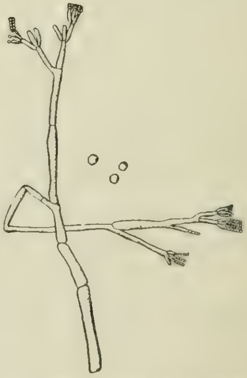

FIG. 120.—*Penicillium chrysogenum Thom. Conidiophore, showing conidial fructification, x 236.6; spores, x 533.3*

Hab. Isolated from soil of oat field, Cornell University, Ithaca, N. Y., July and August, 1910, by the writer.

Writer's culture data:

Color.— Blue-green to slate-gray when old; reverse light yellowish green. In some media lemon-yellow; in others, none.

Odor.— None.

Fifteen per cent gelatin in water, good growth, lemon-yellow color in gelatin, liquefaction rapid, 6–10 days, more or less rapid and complete in all gelatin media used, litmus reaction alkaline. Potato agar, good growth, no yellow color. Potato plugs, good growth, potatoes become yellow. Raulin's fluid, good growth, with age the under surface of mat near test tube assumes a purplish tint, no yellow in fluid. Cohn's solution, not as good growth as in Raulin's fluid, solution becomes yellow. Lactose 3 per cent, slight growth, no coloration of media. Lactic acid 9 per cent, very slight growth. Glycerin 3 per cent, fair growth, no coloration in fluid.

Penicillium geophilum Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 288. *pl. 25, figs. 1–5.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 907. 1903. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 161. 1904–1907.

Colonies orbicular, zonate; zones at first alternating light and dark green, later changing to white and bright green; vegetative hyphæ creeping, branched, septate, hyaline, 4–8μ thick; conidiophores erect, to 360μ high by 6μ thick, hyaline, remotely septate, at the summit with a verticil of usually 9 branches; branches lageniform, swollen at the tip, occasionally curved, 30μ long, carrying very long conidial chains; conidia globose, bright green but appearing almost hyaline, smooth, 3–4μ in diameter.

Hab. Humous soil from woods called Spanderswoud near Bussum, Holland, March, 1901, Koning.

Penicillium desciscens Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 288. *pl. 24, figs. 1–5.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 907. 1903. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 162. 1904–1907.

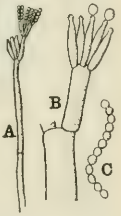

FIG. 121.—*Penicillium desciscens Oud.* A, *conidiophore and conidial fructification, x 60;* B, *part of conidial fructification, x 533.3;* C, *spores, x 533.3*

Colonies green-gray to blue-green, becoming zonate with age; mycelium branched, septate, hyaline, with age becoming guttulate, 2–4μ thick; conidiophores 80–500μ high, hyaline, septate, generally with one or two side branches, with four to six 9–12μ-long primary branches at the apex; each primary branch producing 4–6 basidia, which are 6–9μ long; conidia ellipsoidal to globose, persisting in long chains in liquid mounts, 2.5–3.5μ in diameter.

Hab. Isolated from humous soil from Spanderswoud near Bussum, Holland, March, 1901, Koning; from oat field near Cornell University, Ithaca, N. Y., July and August, 1910, by the writer.

While the fungus does not agree in all particulars with the original description of Oudemans, still in all probability our form is identical with his.

Writer's culture data. Cultures retained for 30 days:

On 15 per cent gelatin in distilled water, and on potato decoction plus 1.5 per cent agar, colonies when young green-gray becoming brownish and zonate with age. Reverse of colonies yellowish green on 15 per cent gelatin in distilled water plus 3 per cent cane sugar and on potato decoction plus 3 per cent cane sugar, plus 1 per cent agar, at first the colonies are blue-green, fading somewhat with age. Reverse of colonies yellowish green to red. Odor none.

Glycerin 3 per cent, slight growth but no fruit. Potato plugs, good growth, blue-green when young becoming gray-green above and with age assumes an orange-yellow coloration on the under surface of the mat. Lactose 3 per cent, same as with glycerine, slight floccose growth throughout medium. Raulin's fluid, very heavy wrinkled mat that is pink at first before fruiting to any extent, during latter half of cultural period the fluid becomes deep wine-red. Cohn's solution, gray when young, after 10 days mat becomes pink beneath, growth less than in Raulin's. Lactic acid 0.9 per cent, slight growth.

Penicillium silvaticum Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 289. *pl. 27, figs. 1–4.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 908. 1903. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 167. 1904–1907.

Colonies orbicular, light brown, nonzonate; vegetative hyphæ creeping, branched, septate, hyaline, 1.3–6.6μ thick; conidiophores erect, to 210μ high, 2–3.3μ thick, hyaline, septate, with a verticil of 5–8 branches on the summit; branches lageniform, inflated at the tip, 16–22μ long; conidia emerging from the apex of the branch in very long (100–160μ) chains, globose, light brown, smooth, 2–3μ in diameter.

Hab. Isolated from humous soil from woods called Spanderswoud near Bussum, Holland, March, 1901, Koning.

Penicillium terrestre n. sp.

Colonies round, yellowish green; sterile hyphæ branched, septate, hyaline, 2–6μ thick; conidiophores 70–375μ high, 2–4μ thick, hyaline, septate, toward the top with one or two primary side branches or bearing simply a verticil of usually 3 primary branches; primary side branches each have at the summit a verticil of 2–5 basidia, or occasionally the primary side branch may bear a secondary branch, both primary and secondary then bearing at their summits 2–5 basidia in a verticil; when only a verticil of primary branches is borne on the summit, each bears 2–5 basidia; branches of the verticil 10–15μ long, cylindrical; basidia 7–11μ long, lageniform; conidia hyaline, globose, 2–3μ in diameter, borne in long chains.

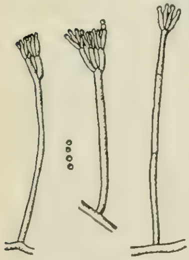

FIG. 122.—*Penicillium terrestre. Conidiophores and conidial fructification, x 236.6*

Hab. Soil of plant-breeding plats, Cornell University, Ithaca, N. Y. Isolated very frequently during winter and spring, 1910–1911, by the writer. Plant pathology herbarium No. 5,916.

Coloniis rotundis, luteo-viridibus; hyphis sterilibus ramosis, septatis, hyalinis, 2–6μ diam.; conidiophoris 70–375μ altitudine, 2–4μ diam., hyalinis, septatis, versus apicem 1–2 ramosis vel solum verticillatim ramos (plerumque tres) ferentibus, ramosis primariis singulis apice 2–5 basidia verticillatim ferentibus, vel interdum ramis primariis ramum secondarium ferentibus, tum ramis secondariis apice 2–5 basidia verticillatim ferentibus; cum solum rami primarii apice verticillatim feruntur, uterque 2–5 basidia fert; ramis secundarius cylindricis, 10–15μ longitudine; basidiis 7–11μ longitudine, lageniformis; conidiis hyalinis, globosis, 2–3μ diam., longe catenulatis.

Hab. In humis, Ithaca, N. Y., Amer. bor.

Penicillium humicola (Oud.) emend. Arch. Néerl. Sci. Nat. ser. 2, **7**: 290. 1902.

Colonies round, at first yellowish green in center, finally dark green, surrounded by yellow margin, which fades into white. Reverse of colony in media containing sugar, red; sterile hyphæ branched, septate, yellowish green, 1–4μ thick; conidiophores 110–200μ high, 1–3.2μ thick, hyaline, septate, either 3 verticillate primary, 8–10μ-long, branches at tip, which produce at their tips 3 secondary branches 5–13μ long, or varying from this to 3 primary branches, the side branches of which may produce 3 or 4 secondary branches, the center sometimes being dichotomous, the dichotomous branches produce at their tips 3 or 4 secondary branches, secondary branches flask-shaped; conidia yellowish green, globose, 2–4.5μ in diameter, in short chains.

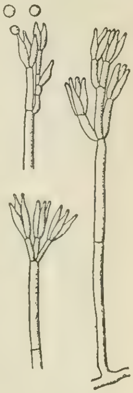

Fig. 123.—*Penicillium humicola (Oud.) emend. Conidiophores and conidial fructification, x 400*

This form varies from *P. humicola* in being larger in form, with less regularity in conidial fructification, and not having primary branches S-shaped or curved.

Hab. Isolated constantly from Dunkirk clay loam near College of Agriculture in plant-breeding grounds, Cornell University, Ithaca, N. Y., by the writer.

Penicillium expansum (Link) Thom, Cultural Studies of Species of Penicillium. U. S. Dept. Agr., Bur. Anim. Indus. Bul. 118: 27–29. *fig. 1.* 1910.

Syn. *Coremium glaucum* Link, Observations, 19. Icones **5**, *fig. 31.* 1809.
Floccaria glauca Grev., Scottish Flora. *pl. 301, figs. 1–4.*
Penicillium glaucum Link (in part), Spec. Plant. **6**: 70. 1824.
Coremium vulgare Corda (in part), Prachtflora, 54. *pl. 25, especially figs. 3, 4, 17, 18, 19, 20, and 21.*
Possibly *Penicillium elongatum* Dierckx.

Colonies on gelatin and potato agar green, becoming gray-green and slowly brown in several weeks (especially when exposed to light), floccose, with concentric zones tufted with short, loose, coremium-like aggregations of conidiophores, not over 1–2 mm. in height except in old cultures containing sugar, broadly spreading, with broad white margin in growing colonies. Reverse somewhat yellowish brown; conidiophores either very short lateral branches of aerial hyphæ, or very long (1 mm. or more), arising singly or grouped with others to form coremia. Conidial fructification consists of the three main branches bearing verticils of branchlets supporting crowded whorls of conidiiferous cells 130–200 by 50–60μ at base in cultures without sugar, with sugar continuing for some weeks to produce a great number of conidia that come to form masses perhaps 1 mm. in thickness, conidiiferous cells 8–10 by 2–3μ; conidia elliptical to globose, 2 by 3.3μ or 3–3.4μ, green, homogenous, persisting in chains when mounted. Colonies begin to liquefy gelatin by sixth day.

Hab. Isolated quite generally from soil by the writer; from sandy and loamy soil, Germany, Adametz.

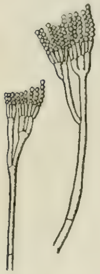

FIG. 124.— *Penicillium expansum (Link) Thom. Conidiophores and conidial fructification, x 236.6*

Amblyosporium echinulatum Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 282. *pl. 11, fig. 1.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 759. 1902. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 179. 1904–1907.

Colonies orbicular, gray-green; vegetative hyphæ hyaline, articulate, branched; fertile hyphæ swollen at tip, up to 200μ high, toward base hyaline, toward top with dilute gray-green branches; branches basidia-like, closely and repeatedly verticillate or spirally arranged, lageniform, continuous, 25μ high; conidia catenulate, at first hyaline and globose, afterward dilute gray-green and ovoid or broad elliptical, truncate at ends, with an apiculus, very minutely spiny, continuous, 8–12 by 6–9μ.

Hab. Isolated from pulverized humous soil from forest called Spanderswoud near Bussum, Holland, June, 1901, Koning.

Monosporium acuminatum var. **terrestre** Sacc., Fung. Ital. *pl. 868.* 1881; Syll. Fung. **4**: 114. 1886. Lindau, Rab. Krypt. Flora Abt 8, **1**: 264. *figs. 1–3* on *p. 262.* 1904–1907.

Colonies spreading, thin, white; conidiophores erect, sparsely septate, dendroidly branched; branches ascending, simple or branched, acute; conidia hyaline, oblong, acrogenous, 5–6 by 3μ.

Hab. On humous soil in Venice in September, Saccardo.

Monosporium silvaticum Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 287. *pl. 22, figs. 1–3.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 905. 1903. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 266. 1904–1907.

Colonies orbicular, white; vegetative hyphæ creeping, branched, continuous, hyaline; conidiophores erect, continuous, hyaline, dendroidly branched, with ultimate branches commonly two- rarely three-forked; conidia singly acrogenous at the apices of the branches, hyaline, obovate, 3 by 2μ.

Hab. Isolated from pulverized humous soil from woods called Spanderswoud near Bussum, Holland, June, 1901, Koning.

Botrytis fulva Link, Spec. Plant. **1**: 58. 1824. Sacc. Fung. Ital. *pl. 696*. 1881; Syll. Fung. **4**: 123. 1886. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 280. 1904–1907.

Syn. *Sporotrichum fulvum* Fries, Syst. Myc. **3**: 418. 1832.
Polyactis fulva Bonord., Handb. Allg. Myk., 115. *figs. 128–159*. 1851.
Dematium ollare Pers., Syn., 697. 1801.

Colonies in form of a stratum, rather thick, spreading, yellow-brown, consisting of thickly intertwined or cobwebby hyphæ; conidiophores much branched; conidia globose, 4–5.5μ in diameter, with fine spines, yellow-brown.

Hab. On moist earth, decaying sorghum culms, on stalks of *Allium cepa*, decaying branches of *Salix pentandra* and other broad-leaved woods, stumps, and so forth, in Germany, Poland, Italy, and France, in summer and autumn. See Lindau, l. c., for statement that this species grows on moist soil.

Botrytis dichotoma Corda, Icon. Fung. **1**: 18. *fig. 244*. 1837. Sacc. Syll. Fung. **14**: 123. 1886. De Wild. et Dur., Prodr. Fl. Belg. **2**: 312. 1898. Cavara, Atti Ist. Bot. Univ. Pavia **3**: 343. *pl. 26, figs. 20–23*. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 281. 1904–1907.

Syn. *Campsotrichum dichotomum* Bonord., Handb. Allg. Myk., 102. 1851.

Colonies small, white with cinnamon-colored spots; conidiophores erect, closely forked, extreme branches blunt and slightly curved inward, hyaline, 12–14μ thick; conidia produced in great numbers in the form of a spiral, globose, often angled from lateral pressure, yellow-cinnamon brown.

Hab. On decaying leaves and moist earth in Bohemia, Corda; near Pavia, Cavara; and in Belgium. See Lindau, l. c., for authority that fungus grows on moist soil.

Botrytis geophila Bonord.

Syn. *Polyactis geophila* Bonord., Handb. Allg. Myk., 115. *fig. 163*. 1851.
Botrytis geophila Sacc., Syll. Fung. **4**: 125. 1886. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 282. 1904–1907.

Colonies gray, delicate; conidiophores short, septate, almost hyaline, upward dichotomously branched, with short, blunt, forked end branches that appear as crutches; conidia small, globose, blackish.

Hab. On moist soil in fir woods in Westphalia, Bonorden.

Botrytis terrestris n. sp.

Colonies at first white, later gray; sterile hyphæ creeping, hyaline, branched, septate, 1.5–3μ in diameter; conidiophores erect, ascending, septate, branched, 2–3.5μ in diameter, 50–200μ high; primary and secondary branches verticillate, dichotomous, or alternate; conidia produced on the ends of the branches, forming more or less compact triangular clusters that average 20–25μ, obovate, somewhat angled, uniform 2.5–3 by 3–4μ, hyaline to light gray. Clusters of conidia separate very easily.

Hab. Isolated from potato soil on experimental plats at North Cohocton, N. Y., by the writer, May, 1911, and grown on soil solution agar, nutrient agar, and straw plugs. Plant pathology herbarium No. 5,919.

Coloniis initio albis, deinde griseis; hyphis sterilibus repentibus, hyalinis, ramosis, septatis, 1.5–3μ diam.; conidiophoris erectis v. assurgentibus, septatis, ramosis, 2–3.5μ diam., 50–200μ altitudine; ramis primariis et secundariis verticillatis, facientibus cæspites densiores, confertiores et triangulos, 20–25μ, obovatis, aequabiles 2.5–3 x 3–4μ, hyalinos v. griseos. Cæspitibus conidialibus facile separabilibus.

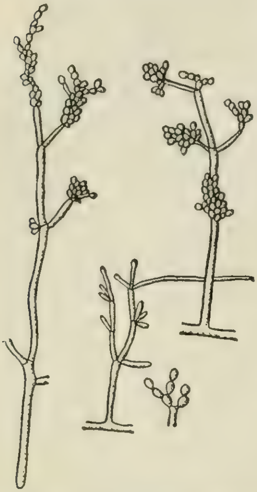

FIG. 125.—*Botrytis terrestris. Conidiophores and conidial clusters, x 355*

Hab. In humis, North Cohocton, N. Y., Amer. bor.

Botrytis cinerea Pers., Tent. Disp. Meth. Fung., 46. *pl.* 3, *fig.* 10. 1797; Syn., 690. 1801. Link, Spec. Plant. **1**: 60. 1824. Fries, Syst. Myc. **3**: 396. 1832. Sacc. Syll. Fung. **4**: 129. 1886. De Wild. et Dur., Prodr. Fl. Belg. **2**: 312. 1898. Wehmer, Beitr. Kenntn. einh. Pilze, **2**: 81. *pl. 3, figs. 12–14.* 1895. Lindau, Verh. Bot. Ver. Brandenb. **47**: 64. 1905; Rab. Krypt. Flora Abt. 8, **1**: 284–290. 1904–1907.

See Lindau, l. c., for synonyms and further bibliography.

Colonies diffuse, gray, gray-green, dark olive-green to brown-black, seldom brown or reddish green, dusted gray from the conidia, loose or dense, up to 2 mm. high; conidiophores erect, unbranched or seldom branched, septate, 11–23μ thick, with blackish brown membrane, toward the summit almost hyaline, at the summit with several (3 and more) somewhat half-globose outgrowths (auswüchsen) from which the conidia are formed singly on very fine wart-like projections. The tip of the conidiophore grows between the outgrowths (warzen), whereby they become separated and placed laterally, occasionally in this position they still carry single conidia. The conidia stand so thickly on the projections (auswüchsen) that thick heads are produced which soon fall off, ovate or elliptical to almost globose, on the base finely apiculate, 9–12 (up to 15)μ long and 6.5–10μ broad, with almost hyaline, hardly brownish membrane.

Hab. Cosmopolitan; on living, dying, or dead plant members; isolated from soil, Switzerland, Lendner.

Botrytis epigaea Link, Spec. Plant. **1**: 53. 1824. Oudemans, Nederl. Kruidk. Arch. ser. 4, **2**: 248. 1884. Sacc. Syll. Fung. **4**: 136. 1886. Lindau, Verh. Bot. Ver. Brandenb. **47**: 65. 1905; Rab. Krypt. Flora Abt. 8, **1**: 299. 1904–1907.

Syn. *Polyactis epigaea* Bonord., Handb. Allg. Myk., 115. *fig. 161.* 1851.

Colonies far-spreading, floccose, at first white, then yellowish-brown to red-brown; hyphæ creeping, septate, 11–16μ thick, with brownish,

thin, granulated membrane. From the principal hyphæ are produced side branches that average 30–40μ long; side branches are mostly without septa, with smooth, bright membrane, on the summit irregularly and slightly swollen and ending in a great number of wholly irregular, thin, 5–7μ–long, hyaline projections (zähnen). The principal stem rarely ends similar to the side branches; conidia borne singly on the projections, globose, 3.5–5.5μ in diameter, hyaline, uniguttulate.

Hab. On barren sandy soil in woods in Germany, Holland, Italy, France, and North America, in summer and autumn.

var. **rosea** Sacc., Fung. Ital. *pl. 689.* 1881; Syll. Fung. 4: 136. 1886. Lindau, Rab. Krypt. Flora Abt. 8, 1: 300. 1904–1907.

Syn. *Hyphelia terrestris* Fries, Syst. 3: 213. 1829.
Trichoderma tuberculatum Pers., Obs. Myc. 1: 12. *pl. 2, fig. 8.* 1796.
Trichoderma nemorosum Pers., Traite Champ. Comest. 1818. (cfr. Fries, l. c)
Trichoderma laeve Schumach., Saell. 2: 236. 1803.
Trichoderma varium Ehren., Sylv. Myc. Berol., 11. 1818.

Colonies reddish; conidiophores standing compact, septate, branched or forked, clavate on the summit; conidia globose, 3μ in diameter, borne on the points of the clavate branches.

Hab. On soil in Germany, Austria, North Italy, Finland, and Siberia, summer and autumn. Lindau, l.c.

Lindau considers this variety as superfluous because of the great variation of the species.

Botrytis purpureospadicea (Fuckel) Lindau.

Syn. *Hyphelia purpureospadicea* Fuckel, Symb., 363. 1869.
Botrytis purpureospadicea Sacc., Syll. Fung. 4: 121. 1886. Lindau, Rab. Krypt. Flora Abt. 8, 1: 305. 1904–1907.

Colonies floccose, up to 5 cm. in diameter, brown-purple; conidiophores branched, 10–13μ thick, nonseptate, finally falling and disappearing; conidia globose, dirty-rose, 5μ in diameter, guttulate.

Hab. On sandy soil between grass near Bundenheim in the Rhine Province (Rheingau), Fuckel.

Lindau considers this an insufficiently known species.

Verticillium terrestre (Link) Lindau.

Syn. *Stachylidium terrestre* Link, Mag. Gesell. Naturf. Fr. Berlin 3: 15. *fig. 21.* 1809; Spec. Plant. 1: 78. 1824. Greville, Scot. Crypt. Fl. *pl. 257.* 1827. Chevallier, Fl. Gén. env. Paris, 1: 70. *pl. 4, fig. 14.* 1826. Fries, Syst. Myc. 3: 391. 1829.
Botrytis terrestris Pers., Myc. Eur. 1: 38. 1822. Bomm. et Rouss., Fl. Myc. env. Brux., 274. 1884. Lambotte, Fl. Myc. Belg. 3: 230. 1880.
Stachylidium candidum Grev., in Werner Trans. 4: 72. *pl. 5, fig. 2.* 1822.
Verticillium terrestre Sacc., Syll. Fung. 4: 152. 1886. De Wild. et Dur., Prodr. Fl. Belg. 2: 316. 1898. Lindau, Rab. Krypt. Flora Abt. 8, 1: 320. 1904–1907.

Colonies white, consisting of thick, cobwebby, branched hyphæ; conidiophores erect, septate, upward with four associated branch whorls;

branches short-blunt, rarely again verticillately branched; conidia globose, soon falling.

Hab. On barren soil and surrounding pieces of wood in Germany, Belgium, England, and Sweden. Lindau, l. c.

Acrostalagmus albus Preuss. var. **varius** n. var.

Colonies effused, thin, subfloccose, white; vegetative hyphæ hyaline, branched, septate, 2–3.5μ; conidiophores creeping, ascending, or erect, branched, 15–75μ high, 2–3.5μ thick; branches continuous, usually simple but occasionally ternately branched, verticillate, alternate toward apex, slightly curved, at the summit producing a cap or head of conidia, 15–36 by 2–3μ; verticils very frequently but 1, never more than 3; cap globose, 3–12μ; conidia hyaline, oblong, variable in size, 2.8–9 by 1–4μ mostly 3.3 by 1.5μ.

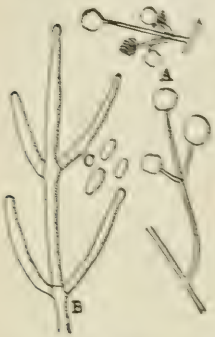

FIG. 126.—*Acrostalagmus albus Preuss. var. varius.* A, *conidiophores and conidial heads, x 230.0;* B, *same enlarged, x 533.3;* C, *spores, x 533.3*

Hab. Isolated from soil of plant-breeding plats, Cornell University, Ithaca, N. Y., and from potato tuber, March, 1911. Plant pathology herbarium No. 5,920.

Varies from type in the shorter conidiophores, fewer verticils, branches being occasionally branched, greater variation in size of cap of conidia and of conidia.

Ascrostalagmus cinnabarinus var. **nana** Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 282. *pl. 10, fig. 1.* 1902.

Colonies orbicular, orange (Sacc. Chromot. No. 21) mixed with red; vegetative hyphæ branched, septate; fertile hyphæ septate, with 2 or 3 series of opposite unicellular branches; branches terminated by 3-rayed verticils, with each ray in the form of a ninepin (36–45μ long) and serving as the support of a glomerule of conidia; conidia ellipsoidal or oblong, rounding at both ends, 5–8 by 3–5μ, united by a gelatinous liquid. All parts of the plant are tinted with excessively weak rose.

Hab. Isolated from pulverized humous soil from Spanderswoud near Bussum, Holland, September, 1901, Koning.

The variety differs from the type in its smaller dimensions, its unicellular, opposite, nonverticillate branches, which are divided into 3 instead of [illegible] rays. Its conidia, on the contrary, are much larger (5–8 by 3–5μ as against 3–4 by 1.5μ).

Spicaria silvatica Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 201. *pl. 30, figs. 1–4.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 910. 1903. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 353. 1904–1907.

Colonies orbicular, light gray-green; vegetative hyphae creeping, hyaline, septate, with forked branching, 1–6μ thick; conidiophores erect, 2–3μ thick, sparsely branched, with branches alternate; branches of different lengths, simple or forked at the tip with 3 verticillately placed, cylindrical, nonseptate, somewhat curving, 10–15μ-long branchlets; conidia in long chains, ellipsoidal or oblong, 6–12 by 4–6μ, hyaline, smooth.

Hab. Isolated from humous soil from woods called Spanderswoud near Bussum, Holland, June, 1901, Koning.

Spicaria decumbens Oud. Arch. Néerl. Sci. Nat. ser. 2, 7: 292. *pl. 28, figs. 1–2.* 1902. Lindau, Rab. Krypt. Flora Abt. 8, 1: 353. 1907.

Colonies hyaline; vegetative hyphae decumbent, septate, closely racemosely branched; conidiophores ascending, septate, simple or branched; branches opposite or alternate, mostly simple, occasionally toward the tips producing short septate branches; end branches 2–5, verticillate, lageniform, 12–18μ long, resembling sterigmata; conidia in long chains, ellipsoidal, hyaline, 3–4μ in diameter.

Hab. Isolated from humous soil from wood called Spanderswoud near Bussum, Holland, June, 1901, Koning.

Spicaria elegans (Corda) Harz.

Syn. *Penicillium elegans* Corda, Icon. Fung. 2: 18. *fig. 74.* 1838.
Hormodendrum hippei Bonord. Handb. Allg. Myk. 77. 1851.
Spicaria elegans Harz, Bull. Soc. Imp. Nat. Moscou 44: 238. 1871. Sacc. Fung. Ital. *pl. 893.* 1881; Syll. Fung. 4: 166. 1886. Oudemans, Arch. Néerl. Sci. Nat. ser. 2, 7: 290. *pl. 20, figs. 1–2.* 1902; Nederl. Kruidk. Arch. ser. 3, 2: 909. 1903. Lindau, Rab. Krypt. Flora Abt. 8, 1: 350. 1904–1907.

Colonies somewhat spreading, white, velvety; vegetative hyphae creeping, hyaline, septate; conidiophores erect, septate, with 2–4 circles of opposite or 3–4 verticillate branches; branches short, fusiform, each divided at the tip into a verticil of 3 branchlets; branchlets lageniform, swollen at the tip; conidia ovate-fusiform, united to form long chains, 4–5 by 3.5–4μ, hyaline.

Hab. On the inside of decaying fir bark in Bohemia, Corda; on decaying willow branches in Vienna woods, von Höhnel; on a piece of decaying wood in humous soil near Bussum, Holland, Koning; on wood and bark in England; on decaying Fistulina in Venice, Saccardo; in summer and autumn.

Spicaria simplicissima Oud., Nederl. Kruidk. Arch. ser. 3, 2: 763. 1903; Lindau, Rab. Krypt. Flora Abt 8, 1: 353. 1907.

Colonies orbicular, with alternating zones of cream-yellow and dirty gray, occasionally zones show tinge of violet; vegetative hyphae creeping, very thin, septate, hyaline, dichotomously branched; conidiophores erect, 40μ high, septate, hyaline, usually unbranched, at the most with a small side branch, on the tip constantly producing three branchlets; branchlets nonseptate, 8–12μ long, verticillate; conidia 2–3μ, in short chains, globose.

Hab. Isolated from humous soil from Bussum, Holland, September, 1903, Koning; from soil of plant-breeding plats, Cornell University, Ithaca, N. Y., in November, 1910, and January, 1911, also from potato tubers. Plant pathology herbarium No. 5,921.

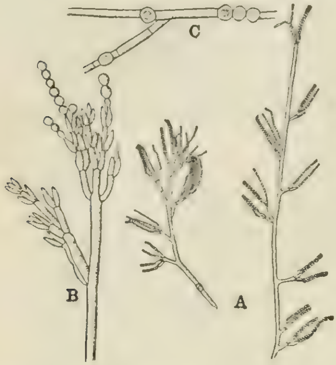

FIG. 127.—*Spicaria simplicissima Oud.* A, *conidiophores and conidial fructification*, x *236.6;* B, *same enlarged*, x *533.3;* C, *chlamydospores*, x *533.3*

Naematogonium humicola Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 288. *pl. 23, figs. 1–3.* 1902. Nederl. Kruidk. Arch. ser. 3, **2**: 905. 1903. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 360. 1907.

Colonies orbicular, velvety, at first white, later light green, finally cream-colored (Sacc. Chromot. No. 27); conidiophores ascending, 2.2–3.3μ thick, hyaline, septate, unbranched, consisting of perfectly cylindrical long cells alternating with swollen, shorter, fertile cells; conidia sessile, globose, 3–4μ in diameter, or ellipsoidal 3–6 by 2–4μ, almost hyaline.

Hab. Isolated from pulverized humous soil from woods called Spanderswoud near Bussum, Holland, June, 1901, Koning.

Trichothecium roseum Link, Mag. Gesell. Naturf. Fr. Berlin **3**: 18. *fig. 27.* 1809.

Syn. *Puccinia rosea* Corda, Icon. Fung. **1**: 6. *fig. 98.* 1837.
Dactylium roseum Berk. Lambotte, Fl. Myc. Belg. **3**: 244. 1880.
Cephalothecium roseum Corda, Icon. Fung. **2**: 14. *fig. 62.* 1838.
Cephalothecium candidum Bonord., Handb. Allg. Myk., 81. *fig. 89.* 1851.

Colonies forming a powdery or velvety covering, wide-spreading, moldlike or cobwebby, at first white, later rose-red; vegetative hyphæ septate, branched, 1.5–6μ; conidiophores erect, sparsely or nonseptate, mostly unbranched, 200–500 by 3–3.5μ; conidia acrogenous, produced singly one after the other, adhering to the upper part of the conidiophore to form a loose head, pyriform, two-celled, slightly constricted at septum, at first hyaline, later rose, 12–22 by 8–13μ.

Hab. Isolated from soil of plant-breeding plats, also from oat field in autumn and spring, Cornell University, Ithaca, N. Y., 1910–1911, by the writer. Plant pathology herbarium No. 5,922.

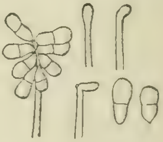

FIG. 128. — *Trichothecium roseum Link. Conidiophore and conidia*, x *236.6*

Mycogone nigra (Morgan).

Syn. *Monotospora nigra* Morgan, New North American Fungi. Jour. Cincinnati Soc. Nat. Hist. **18**: 44. *pl. 3, fig. 20.* 1895.

Colonies at first hyaline, later showing yellowish tint, and finally becoming black-brown and zonate. In rapidly growing colonies, the hyphæ near the margin are aerial as well as immersed and show a distinct yellow tint. Mycelium branched, septate, with numerous fertile branches bearing a single spore at the apex, 2–4.5μ thick; conidiophores varying from scarcely none to a length of 30μ, width 2–3.5μ, ascending or erect; conidia uniseptate, upper cell dark brown, smooth, thick-walled, globose, 12–15μ in diameter, lower cell hyaline to slightly colored, smooth, hemispherical, 8–10 by 9–12μ. Intercalary cells are often formed. Variations in which the lower cell is not cut off, and again when a second small cell is formed, occur in culture. All conidia may probably be considered as chlamydospores.

Hab. Growing on old cornstalks, Preston, Ohio, Morgan; a very common form in soil. Isolated repeatedly during fall, winter, and summer from cultivated soil, Cornell University, Ithaca, N. Y., by the writer. Plant pathology herbarium No. 5,923.

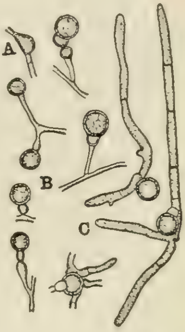

Fig. 129.—*Mycogone nigra* (*Morgan*). A, *chlamydospore, x 236.6;* B, *conidiophores and conidia, x 236.6;* C, *germinating conidia, x 236.6*

Dematiaceae

Torula No. 7 Hansen. Kohl, F. G., Die Hefepilze, 297. 1908.

In wort, this species produces 1 vol. per cent alcohol, does not invert cane sugar. In yeast water containing 15 per cent dextrose, it produces 5.3 vol. per cent alcohol. The temperature limits of growth are 0.5° C. and 38–39° C.

Hab. Found in soil beneath a grape vine, Hansen. Kohl, l. c.

Torula lucifuga Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 294. *pl. 36, figs. 1–4.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 916; Cat. Rais. Pays-Bas, 504. 1904. Sacc. Syll. Fung. **18**: 566. 1906. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 592. 1907.

Colonies orbicular, at first straw-colored, later with dark tints of many colors above (spotted), below olivaceous to black; vegetative hyphæ creeping, hyaline, nonseptate, variously flexuose and curved, branched, submerged in media, at length with single, later with two or more closely lying, septa, which form the conidial chains; conidial chains soon becoming dark-colored; conidia globose, ellipsoidal, or oblong, dark- or light-colored, contents full of small vacuoles, 10–22 by 8–10μ.

Hab. Isolated from humous soil from woods called Spanderswoud near Bussum, Holland, September, 1901, Koning.

Stachybotrys atra Corda, Icon. Fung. **1**: 21. *fig. 278 B.* 1837; Anleit., 64. *pl. B 18, figs. 5–8.* 1842. Sacc. Syll. Fung. **4**: 269. 1886. De Wild. et Dur., Prodr. Fl. Belg. **2**: 329. 1898. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 628. 1904–1907.

Colonies spreading, at first hyaline, becoming black with age, zonate in the center, margin entire; mycelium hyaline, septate, 5–6μ, with branches almost at right angles, with oval, ellipsoidal, or globose chlamydospores up to 12μ in diameter; articulate with age; conidiophores fuliginous near the apex, almost hyaline at the base, branched, septate, 65–75μ high by 2–4μ thick, slightly alternate toward apex, bearing on the summit a whorl of papillate basidia; basidia 10–12 by 4.5–5μ; conidia single, smooth, ellipsoidal, usually with acute ends and mostly with two oil drops, slightly colored when young to fuliginous and black when mature.

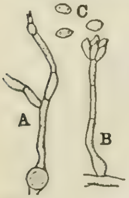

FIG. 130. — *Stachybotrys atra Cda.* A, *hypha with chlamydospores, x 236.6;* B, *conidiophores and basidial cells, x 236.6;* C, *conidia, x 236.6*

Hab. Isolated from arable soil, North Cohocton, N. Y., summer, 1911, by the writer. Plant pathology herbarium No. 5,924.

Stachybotrys cylindrospora n. sp.

Colonies round, thin, diffuse, becoming black with age; mycelium branched, septate, hyaline, 0.5–3μ; conidiophores hyaline at base, fuliginous toward apex, branched, septate, attenuate toward tip, 40–65μ high, bearing on the summit from 3–9 sterigmata; sterigmata subclavate, with or without short papilla, 8-11 by 4–5μ; conidia borne singly, smooth, subcylindrical to sometimes ovate, 6–16 by 3.8–5μ, hyaline when young, becoming fuliginous and nearly opaque with age.

Hab. Isolated from arable soil, North Cohocton, N. Y., August, 1911, by the writer. Plant pathology herbarium No. 5,925.

Coloniis rotundis, tenuibus, effusis, nigrescantibus; mycelio ramoso, septato, hyalino, 0.5–3μ; conidiophoris basi hyalinis, versus apicem fuligineis, ramosis, septatis, versus apicem attenuatis, 40–65μ in altitudine, apice 3–9 sterigmata ferentibus; sterigmatibus subclavulatis, cum vel sine papillula, 8–11 x 4–5μ; conidiis solitariis, levibus, subcylindricis vel ovatis, 6–16 x 3.8–5μ, primum hyalinis, deinde fuligineis et demum fere opacis.

Hab. In humis, North Cohocton, N. Y., Amer. bor.

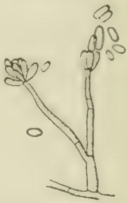

FIG. 131. — *Stachybotrys cylindrospora. Conidiophore, basidial cells, and conidia, x 236.6*

Hormodendrum Hordei Bruhne, in Zopf's Beitr. **4**: 1–42. *pl. 9.* 1894.

Colonies brown at maturity, circular, dense; mycelium brown, septate, branched, 3–6μ thick; conidiophores simple, septate, ascending or erect, 50–100μ; conidia various, some cylindrical with ends rounded, truncate, or subattenuate, others ellipsoidal, ovate, or subglobose, regular or somewhat angled, with age many become uniseptate and verrucose, 4–14 by 3–5μ, chains of conidia short.

Hab. Isolated from soil taken from oat field, Ithaca, N. Y., July, 1910, and experimental field in North Cohocton, N. Y., by the writer. Plant pathology herbarium No. 5,926.

The fungus has been cultivated on potato agar, gelatin, nutrient agar, and straw plugs. The conidiophores do not vary materially, and spores always show septa and are verrucose. Description is taken from fungus growing on straw plugs, gelatin, and nutrient agar.

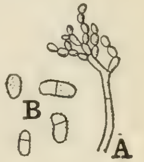

FIG. 132.—*Hormodendrum Hordei Bruhne.* A, *conidiophore and conidia x 355;* B, *conidia enlarged, x 800*

Hormodendrum cladosporioides (Fres.) Sacc., Mich. **2**: 148. 1881.

Syn. *Penicillium cladosporioides* Fres., Beitr., 22. *pl. 3, figs. 23–38.* 1850.

Colonies olivaceous, round, dense; mycelium branched, septate, with age becoming articulate and guttulate, 2–5μ in diameter; conidiophores erect or ascending, branched, 100–200μ high by 3–5μ in diameter, olivaceous, toward apex gradually attenuate, ultimate branches copiously dividing with predominant tendency to dichotomy, septate, articulate above; conidia cylindrical to broad oval, olivaceous, 3–6 by 2.5–3.6μ, continuous or inferior ones rarely septate.

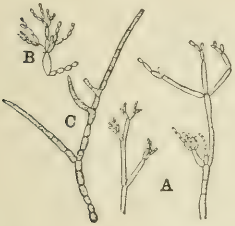

FIG. 133.—*Hormodendrum cladosporioides (Fres.) Sacc.* A, *conidiophores and conidia, x 236.6;* B, *ultimate branches of conidiophore, and conidia, x 236.6;* C, *old articulate hypha, x 236.6*

Hab. Isolated from oat field, July, 1910, and from plant-breeding plats, Cornell University, Ithaca, N. Y., November and December, 1910; and repeatedly by the writer during summer, 1911, at North Cohocton, N. Y., from the experimental potato plats. Plant pathology herbarium No. 5,927.

Hormodendrum pallidum Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 293. *pl. 34, figs. 1–3.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 914. 1903; Cat. Rais. Pays-Bas, 506. 1904. Sacc. Syll. Fung. **18**: 581. 1906. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 704. 1907.

Colonies orbicular, gray (Sacc. Chromot. No. 2), not plainly zonate; vegetative hyphæ creeping, articulate, partly thin with homogenous protoplasm, partly thicker with foamy contents; conidiophores erect, very light gray, upward dendroidly branched; primary and even secondary branches decussate, each succeeding branch and branchlet shorter than preceding, consisting of single cells, constricted at septa so as to make separation very easy; ultimate articulations small and serving as conidia, variable in size, 12–20 by 5–8μ.

Hab. Humous soil from Spanderswoud near Bussum, Holland, June, 1901, Koning.

Bispora pusilla Sacc., Mich. **1**: 78. 1877; Fung. Ital. *pl. 21.* 1877; Syll. Fung. **4**: 343. 1886. Oudemans, Arch. Néerl. Sci. Nat. ser. 2, **7**: 292. *pl. 33, figs. 1–2.* 1902; Nederl. Kruidk. Arch. ser. 3, **2**: 766. 1903. Lindau, Rab. Krypt. Flora Abt. 8, **1**: 768. 1907.

Colonies spreading, black; vegetative hyphæ filamentous, partly submerged and partly superficial, brown-black, articulate; conidiophores erect, uniformly brown, with the exception of one or two cylindrical, short, and pale basal cells; conidia in simple or branched chains, elliptical, rounding at ends, rather thick-membraned, equally two-celled, not at all or slightly constricted at the septum, at first hyaline, then light brown, and finally dark brown, 9–12 by 4–5μ.

Hab. Isolated from piece of decaying wood in humous soil from Spanderswoud near Bussum, Holland, June, 1901, Koning; on decaying oak and willow from various places.

Stemphylium botryosum Wallr., Fl. Cr., 300. 1831. Sacc. Syll. Fung. **4**: 522. 1886.

Syn. *Urocladium botrytis* Preuss., in Linnea **24**: 111. 1851; Sturm Pilze **6**: 83. *pl. 42.* 1851. Oudemans, Arch. Néerl. Sci. Nat. ser. 2, **7**: 293. *pl. 35, figs. 1–3.* 1902.

Colonies very dark, orbicular; vegetative hyphæ creeping, very extended, thin, irregularly branched, at first hyaline, then becoming light brown and finally dark brown, septate, flexuose, more or less moniliform; branches ordinarily short, flexuose, simple or branched, hyaline or colored, more or less rough from the small abortive excrescences, simple or forked at the summit, and serving as support to the numerous conidia; conidia terminating the primary as well as the secondary branches, with short pedicel, sometimes nearly globose, sometimes elliptical or oblong, divided horizontally into 2–6 compartments of which one or several present a vertical or oblique septum, isabel-colored to brownish-black, 25–40 by 16–20μ; surface of conidia with age finely dotted.

Hab. Isolated from humous soil from woods called Spanderswoud near Bussum, Holland, September, 1901, Koning.

Alternaria fasciculata Cooke & Ellis.

Syn. *Macrosporium chartarum* Peck, Rpt. Bot., Rpt. New York State Museum **25**: 93. 1873.
Macrosporium fasciculatum C. & E., Grev. **6**: 6. *pl. 96.* 1877.
Macrosporium Maydis C. & E., l. c., 87.
Macrosporium Tomato Cooke, Grev. **12**: 32. 1883–1884.

Conidiophores brown, erect or ascending, irregularly curved, solitary or cæspitose, septate, diameter uniform, 40–130μ long by 3μ wide; conidia dark brown, oblong ovate, minutely apiculate, 9–14μ wide by 35–90μ long, endochrome transversely 2–7 septate with usually several longitudinal septa, the apical cell short or elongated into a straight, somewhat hyaline beak.

Hab. Fruiting freely in pure cultures; on dead leaves and decaying vegetable matter of all kinds. Isolated from soil of oat field and plant-breeding plats, Cornell University, Ithaca, N. Y., by the writer.

Alternaria humicola Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 292. *pl. 32, figs. 1–5.* 1902.

Colonies at maturity orbicular, black-green (Sacc. Chromot. No. 34); fertile hyphæ well developed, hyaline, articulate, 3-5μ in diameter, racemosely branched; conidia polymorphic, cylindrical, obclavate, oblong, lageniform, at first hyaline, later honey-colored, thin, dark, finally black-green and fuliginous, variable in size, maximum 16 by 50μ, 3–7 septate, muriform, in advanced age dense and very finely roughened, slightly or nonconstricted at septa.

Hab. Isolated from humous soil near Bussum, Holland, March, 1901, Koning.

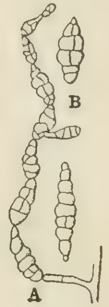

Fig. 134. — *Alternaria fasciculata* Cooke & Ellis. A, *conidiophore and conidial chain, x 236.6;* B, *conidia enlarged, x 533.3*

Stilbaceae

Stysanus difformis Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 296–297. *pl. 29, figs. 1–6.* 1902.

Creeping mycelium filamentous and hyaline; coremia gregarious, erect, dark olive, 2.5 mm. high by 120–220μ broad, with unequal wavy or often flexuose surface, thickened toward the base, toward the top sometimes producing a lateral branch, consisting of filiform, closely-united, septate hyphæ, which are intense avellanate in color; capitulum as regards form comparable to a deformed pileus that is depressed and has its margin repand or slightly incised, of the same color as the stipe, consisting of slender, filiform, fertile, septate, once- or twice-dichotomously-branched hyphæ, which are hyaline downward and avellanate olivaceous upward; branches septate, at the top producing the conidia; conidia globose or short elliptical, intense avellanate, 2.5–3μ in diameter, united in chains.

Hab. Found on decaying wood from humous soil of forest of Spanderswoud near Bussum, Holland, May, 1901, Koning.

Tilachlidium humicola Oud., Arch. Néerl. Sci. Nat. ser. 2, **7**: 297–298. *pl. 12, figs. 1–7.* 1902.

Tufts orbicular, snow-white, woody; primary threads ascending, cylindrical, 35–40μ thick, composed of very slender little fibrils (filaments) that are articulate, hyaline, and closely united, surrounded on every side by secondary basidiomorphic filaments; basidiomorphic filaments 40–80μ high, diverging, simple, continuous, flexuose, arising from the primary threads, subclavate; capitula of conidia globose, terminal, 15–18μ in diameter, distended with gelatin, at length on drying becoming condensed; conidia light green, oblong or ovoid, 6–7 by 3–5μ.

Hab. Isolated from humous soil from forest of Spanderswoud near Bussum, Holland, May, 1901, Koning.

SUMMARY

The fungous flora of the soil is taken to consist of obligate saprophytes and facultative parasites. The former are by far the more abundant in the soil.

Many facultative parasites can be directly isolated from the soil, as shown by the isolation of *Colletotrichum* sp., *Fusarium* sp., *Macrosporium* sp., *Helminthosporium* sp., by Beckwith; *Pythium de Baryanum* Hesse, by Butler; *Rhizopus nigricans* Ehren., by Hagem and by the writer; *Trichoderma Koningi* Oud., by Oudemans and by the writer; *Trichoderma lignorum* (Tode) Harz, *Trichothecium roseum* Link, *Fusarium oxysporum* Schlecht. (*Fusarium orthoceras* Appel), and *Hormodendrum Hordei* Bruhne, by the writer.

Some facultative parasites are very widely distributed, as is shown by the isolation of *Rhizopus nigricans* Ehren., *Trichoderma Koningi* Oud., *Pythium de Baryanum* Hesse. All three species have been isolated in Europe. The first two have been isolated by the writer at Ithaca, N. Y. The last-mentioned species is known to be generally distributed in the United States, although it has not been isolated.

The isolation of soil fungi, because of specialization as to food, temperature and moisture requirements, and aerobic or anaerobic conditions, requires different technic and media.

A fungus should not be considered as belonging to the soil flora unless it has been directly isolated or has been shown under control experimentation to live in the soil. Control experimentation consists in growing a crop from absolutely clean seed in sterilized and nonsterilized soil, all other conditions being identical. This latter method of proof has shown, so far as the " Wurzelbrand " of sugar beets is concerned, that *Phoma Betae* Fr. winters on the seed balls and not in the soil, while *Pythium de Baryanum* Hesse and *Aphanomyces laevis* de Bary winter as saprophytes in the soil and not on the seed balls.

The history of the study of the fungous flora of the soil consists of two definite lines of study: one line consists of an isolation of soil forms in order to obtain a knowledge of the forms themselves prior to making biochemical studies, and also to obtain a knowledge of the habitat and the distribution of the species; the other line consists in obtaining a knowledge as to whether a facultative parasite does or does not live over winter in the soil.

Failure of the writer to isolate Rhizoctonia from Long Island soil that was growing a crop of diseased potatoes may be explained on either of the two following grounds: the fungus does not live as a saprophyte in the soil, but is carried over winter on the seed; or the fungus may have been overgrown in the plates by more rapidly growing species, such as some of the species of Mucor or Fusarium. Species of both genera were present in the plates.

Soil three months after application of sulfur yielded the same species of fungi as did the soil that had had no such application.

The taxonomic considerations include the presumable facultative parasites of the soil, with references to literature but no descriptions; and the obligate saprophytes that have been isolated from the soil thus far, together with standard descriptions. The whole includes some one hundred and thirty-two species and varieties.

CONCLUSION

The need is urgent for a study of the fungi in soils generally recognized as sick to some particular crop, as well as of the relation of these fungi to crop rotations, fertilizers, and fungicides. Do not the debris of the crops in the rotation serve as excellent pabula for the fungi that produce the disease in question? Which crops are of this nature? What effect on the soil fungi results from the addition of various kinds of fertilizers? Is the application of fungicides such as sulfur effective in changing the fungous flora? If so, in what way? These are but a few of the questions that need elucidation.

More should be known of those fungi generally recognized as facultative parasites. Are not some of the species carried over from year to year on or in the seed, or do they live as saprophytes in the soil during the winter? Too often it is said without the proper evidence, that a fungus is a soil organism. The ease with which error can be made is shown by the fact that, with the exception of the past two or three years, since 1895 *Phoma Betae* Fr. has been considered as living in the soil in sugar beet sections. It is now quite conclusively demonstrated to be carried over on the seed balls and not in the soil. It seems to the writer that if a more detailed and far-reaching study were made of this phase of the question, it would be far more remunerative in many instances than a study of the control alone, after fungi have made a sick soil.

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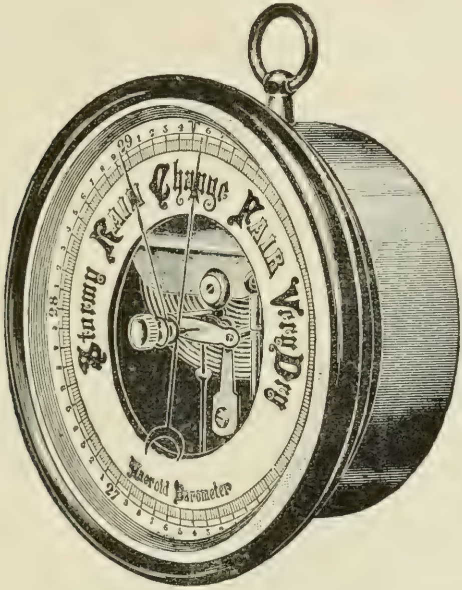
Department of Meteorology

FROSTS IN NEW YORK



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By WILFORD M. WILSON

ITHACA, N. Y.
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FROSTS IN NEW YORK

WILFORD M. WILSON

Local topography, particularly with reference to elevation, slope, and proximity to large bodies of water, exerts so marked an influence on the climate of a place that in such a State as New York, with its mountains, valleys, lakes, and plateaus, any generalizations of climatic conditions that would be of value to the practical farmer become extremely difficult, if not impossible. In some respect nearly every locality enjoys a climate of its own. This is true with regard to frosts in particular, for local topography undoubtedly influences the occurrence of frost to a greater degree than it does any other climatic element. The average temperature or rainfall of a place may be approximated very closely from the average temperature or rainfall of places some distance away; but where there is an appreciable variation in the topography, the frost records of one place cannot be regarded as an absolute guide for the frost conditions of another, although the distance between the places may be only a few miles. Every farmer has learned by experience that frost liability varies for even so small an area as his own farm. For this reason, it has been considered advisable to present the frost records for New York in much greater detail than has been attempted heretofore.

Records of frost for several places in nearly every county are given in the tables at the end of the bulletin. If accepted with due regard to local topography (the effect of which will be pointed out in some detail further on) and in the light of practical experience, these records should enable the farmer to approximate very closely the frost liability of his own locality. No means has yet been devised that can be employed economically by the general farmer to protect large areas from frost; nevertheless, the sort of knowledge derived from the records has a distinct value, which lies in the fact that it makes possible the adjustment of the crop scheme to accord with the requirements of the climate. The frost liability of a place cannot be changed, because it is based on climate and climate does not change; but with a knowledge of the climate in respect to frost, varieties suitable to the locality may be selected and the time of planting and harvesting so regulated as to avoid risk of injury by frost, or at least to reduce the necessary risk to a minimum.

MEANING OF THE TERM FROST

Frost is defined commonly as the moisture of the air condensed at freezing temperatures on plants or other objects near the surface of the earth. It is obvious, therefore, that the temperature of the surface on which frost forms must be at or below the freezing point. Since ice forms at a temperature of 32° F. and it is the formation of ice in the intercellular spaces of a plant that results in injury, the temperature of the plant thus becomes the determining factor, and not the appearance of any deposit of frost on its surface. When frost forms on a plant, it is good evidence, of course, that the exterior of the plant is at or below the freezing point of water; but if the temperature at which condensation of moisture in the air takes place is below freezing, as is frequently the case, ice may form in the intercellular spaces of the plant and destroy it without any deposit of frost appearing on its surface. For this reason, the term " frost " as used in this bulletin is to be understood as signifying injurious temperatures without regard to any deposit of ice that may or may not have appeared on the exterior of plants or other objects.

HOW OBSERVATIONS OF FROST ARE MADE

It is the practice of observers connected with the United States Weather Bureau to record three degrees of frost — light, heavy, and killing. A light frost is recorded when only the tenderest plants are injured; a heavy frost, when the injury is more marked and the hardier plants are damaged; and a killing frost, when the staple products of the region are injured severely or are killed. When no deposit of frost occurs and the temperature of the air as indicated by the thermometer falls during the night to 32° F., a killing frost is recorded also. The charts and tables presented herewith are based on records of killing frosts only.

The records of frosts made at the regular Weather Bureau stations in the State — New York City, Albany, Canton, Syracuse, Oswego, Rochester, Buffalo, Ithaca, and Binghamton — represent to a considerable degree the conditions with respect to frost that obtain in those cities.

FROSTS IN CITY AND COUNTRY

It is well known that the air over cities, particularly on clear nights when frost is likely to occur, almost invariably is warmer than the air over the open country. A comparison of the minimum night temperatures in the city of St. Louis, Mo., with those at Forest Park, a suburb of St. Louis, for a period of five years shows that the air at night over the city averaged 4.6° warmer than that over the suburb. For the month of September the average difference at night was 9°. A similar comparison of observations made since 1882 at the United States Weather Bureau station in the city of Columbus, Ohio, and on the campus of Ohio State University, three miles distant, shows that the air six feet above ground at the university is 3.3° colder at night than that over the city. Comparison of country and city temperatures at many other places gives essentially the same results.

The higher night temperatures of cities are attributed mainly to the heat given off from buildings and pavements, and to the effect of smoke from the many city fires, which collects over cities on quiet nights and, by retarding the escape of heat from the surface, tends to hold the air at a higher temperature than would obtain otherwise. For this reason, records of frost made in large cities cannot be regarded as a reliable guide to the occurrence of frost in the open country; and, while the records of frosts made in the cities of the State have been retained in the tables, they have been disregarded, for the most part, in making up the accompanying charts.

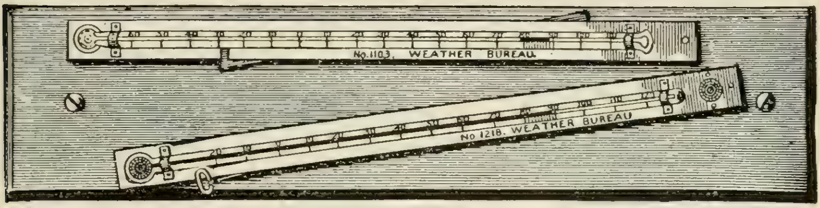

FIG. 135.—*Maximum and minimum thermometers (Weather Bureau pattern). Price, mounted as shown, about $8*

FROST IN THE OPEN COUNTRY

The observations of frost and the temperatures recorded by cooperative observers of the Weather Bureau — who, in the main, are located in the open country or in small villages — may be considered as representing very closely the conditions that obtain on the farm.

The instruments used by cooperative observers are carefully standardized and their exposure is as nearly uniform as possible. The thermometers — a maximum registering the highest temperature in each twenty-four hours, and a minimum registering the lowest — are exposed in shelters of standard construction so that the results are strictly comparable. Generally, the thermometers are placed about four feet above ground, and their readings indicate the temperature of the air at that elevation.

The practice of recording a killing frost when the air temperature at a height of four feet above ground falls during the night to 32° has been objected to on the ground that it does not represent the temperature of the air in contact with plants at the surface. This is true, but it may be pointed out also that the temperature of the air in contact with the plants does not represent the temperature within the intercellular spaces, where injury from freezing occurs. Moreover, plants differ greatly in their ability to withstand cold, and a temperature that will destroy at one stage of the plant's development may cause little or no injury at another stage. Again, injury may depend on other conditions. If the water that is abstracted from the cells by the process of freezing and that congeals in the intercellular spaces is again returned to the cells—that is, reabsorbed—as is sometimes the case, there will be little or no injury to the plant. This occurs when the process of thawing takes place very slowly. A cloudy morning or a cold rain after a frost is often the means of saving a crop by retarding the thawing process. From the foregoing, it will be seen that it is very difficult, if not impossible, to select a critical or injurious temperature that will apply in all cases; and it is even more difficult to choose a place where such a temperature may be obtained.

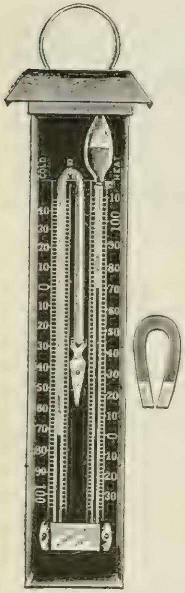

FIG. 136.—*Six's pattern maximum and minimum thermometer. This instrument gives the highest and the lowest temperature for each day, also the current temperature at any time. It is a very excellent thermometer for farm use. Price, $2 to $5*

It is a common experience that vegetation at the surface is sometimes killed when the temperature of the air four feet above the surface remains above freezing; but rarely is there an absence of frost or of injurious temperature when the air temperature four feet above the surface falls to 32°. This is due to the fact that on clear, quiet nights when frost is likely to occur, the air at the surface is nearly always colder than it is a few feet above the surface. This difference may amount to as much as 10°, or even 15°, in as many feet, but usually it is much less. The difference is greater on clear nights than on cloudy nights, for clouds act as a blanket and retard the escape of heat from the earth, thus tending to maintain the whole stratum of air between the earth and the clouds at a higher temperature than if no clouds were present. The difference is greater also on quiet nights, for winds mix the air, preventing the colder, heavier air from settling to the ground and thus maintaining the temperature more uniform. Hence, since the temperature at night usually increases from the surface upward to a certain limit, which is above the height attained by ordinary vegetation, it is obvious that freezing temperatures may occur at the surface when the air temperature four feet above is considerably above freezing, but rarely, if ever, will vegetation at the surface escape injury when the temperature at a height of four feet falls to 32°.

Moreover, the records of cooperative observers are made mostly from instruments located in shelters designed to screen the thermometers from the direct rays of the sun; but such shelters act also as a hindrance to radiation of heat, particularly on clear, quiet nights, so that shelter temperatures are somewhat higher on such nights than open-air temperatures. Professor Cox found that the average temperature of the air at night inside a shelter five inches above ground was about 3° higher than the outside air temperature at the same elevation. Therefore, it would seem that the practice of recording a killing frost when the temperature in the shelter at the height of the thermometers falls to the freezing point is justified.

In this connection it may be pointed out that for tree fruits this practice cannot be justified on these grounds. In tree fruits the blossom is the point where injury occurs, and the blossom usually is more than four feet above ground. Since on frosty nights the temperature increases with the elevation, a freezing temperature at the height of the thermometers may not mean a critical temperature at the height of the blossom. In considering the accompanying frost data from the viewpoint of fruit culture, some allowance should be made for difference in temperature due to difference in elevation. Just how much allowance should be made in individual cases depends on the condition of the sky, the soil, and the wind; but when the sky is clear and there is little air movement, a shelter temperature of 30° should be considered critical at a height of ten to fifteen feet above the ground.

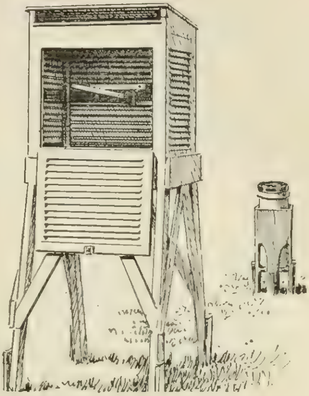

FIG. 137.— *Thermometer shelter and rain gauge for cooperative observers*

EFFECT OF LARGE BODIES OF WATER ON FROST

Under similiar conditions land warms and cools about five times as rapidly as does water. For this reason, the air over large bodies of water usually is cooler in the daytime and warmer at night than the air over adjacent lands. During the winter months the temperature of the water is lowered to such a point that seas and lakes remain comparatively cool throughout the spring and exert a twofold influence on the air temperature for a considerable distance inland: (1) the cold air from above the water tends to retard vegetation until the period of spring frosts has passed; (2) since the air over the water partakes of its temperature, which is considerably above the freezing point during the period of spring frosts, it tends to hold the temperature of the air over adjacent lands, particularly at night, above the point of danger. In the fall the water gives off the large quantities of heat stored up during the warm summer months and thus wards off frosts.

For these reasons, a location near a large body of water enjoys an immunity from frost not found in inland localities. Reference to the accompanying charts of the last killing frost in spring and the first in fall will make this clear. In New York the prevailing winds are from a westerly direction, and for this reason the east side of a body of water is considered most favorable so far as freedom from frosts is concerned. The influence of a body of water also extends farthest on its east side, the distance depending mainly on the size of the body of water and on the slope of the land. The distance is greater for large bodies of water and for land that slopes gently away from the water. For example, the south shore of Lake Erie in New York rises abruptly from the water and the influence of the lake is appreciable for a distance of only a few miles inland; while the influence of Lake Michigan, because of the gentle slope

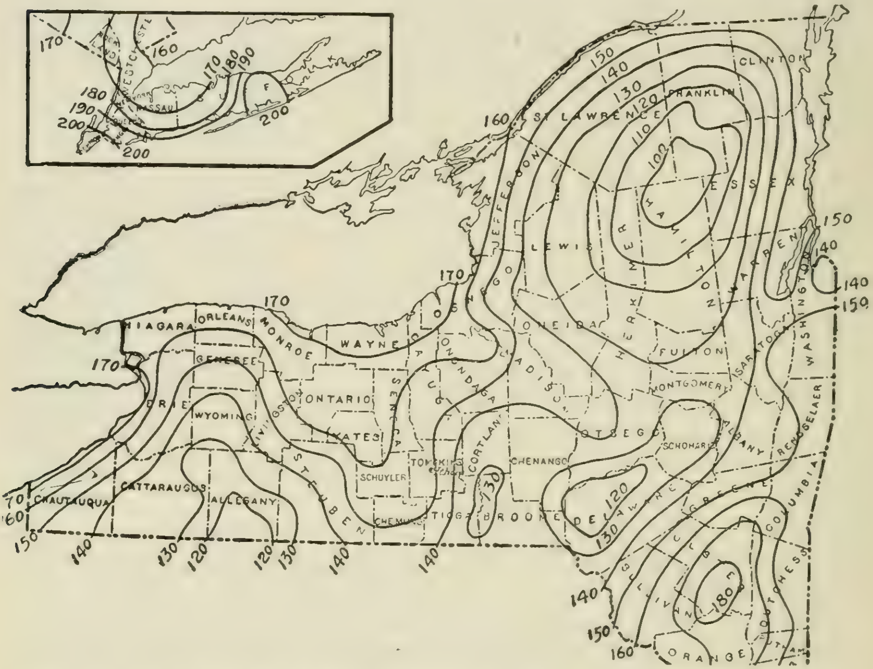

FIG. 138.—*Average number of days between the last frost in spring and the first in fall*

of its eastern shore, extends in some places probably halfway across the State of Michigan.

EFFECT OF ELEVATION ON FROST FREQUENCY

Every farmer knows that frost is less likely to occur at moderate elevations or on low hills than in low places, and what has been said regarding the increase in temperature at night from the surface upward might seem to afford a sufficient explanation of this fact. However, there are several causes that operate to give elevated lands a greater immunity from frost than adjacent valleys enjoy. A valley usually is shaded for a longer period, both in the morning and in the evening, than are the uplands, and therefore it goes into the night with a smaller store of heat with which to combat the frost. This, however, does not explain the immunity from frost on hillsides that face away from the sun for a large part of the day, which brings us to the consideration of the principle of air drainage.

The cooling of the air at night begins at the surface, and when the layer of air in contact with the surface becomes cooler than the air about it, it also becomes heavier and begins to slide down the slopes for the same reason that water runs down hill. Hence, the cold air accumulates in the valleys. When it leaves the hilltops its place is taken by warmer air, which in turn is cooled by contact with the cold surface and, becoming heavier, starts on its journey to the valley. Thus, a gentle circulation is maintained throughout the night. Again, the stronger winds usually present on plateaus and hills tend to maintain a more uniform temperature by mixing the air and preventing its colder parts from settling to the surface.

There are many striking examples of the effect of this draining of cold air away from the hills and its accumulation in the valleys. F. W. Stow, of the Royal Meteorological Society, mentions an instance of this character, which shows how remarkably clear-cut the line between frost and no frost sometimes is:

> At the end of May, 1894, there was a frost in the interior of England. After the frost, the ash trees in the valley bottoms were completely frostbitten; those that grew somewhat higher up on the slopes were frostbitten below their crowns, but the crowns were green; those that grew on still higher ground had their lower halves frozen, but the upper halves were green; while the ashes growing on the hills surrounding the valley were not injured in the slightest degree.

Professor Howard, Secretary of the Missouri State Board of Horticulture, calls attention to the fact that certain sections in that State nearly always escape injury from spring frosts. He instances the famous peach region about the town of Koshkonong, in Oregon county. George Reeder, of the United States Weather Bureau, after a careful study of the topography and climatic conditions, reaches the conclusion that the immunity of the orchards in that vicinity from frost results from drainage of the cold air away from the orchards, and, although the slope of the land is slight, it is sufficient to ward off frost.

The famous regions known variously as "thermal belts," "frostless zones," or "verdant zones," found in certain mountainous districts of North Carolina and elsewhere, result from air drainage. The verdant zone in Macon county, North Carolina, in the valley of the Little Tennessee River, was described by Silas McDowell in 1861. It lies between 300 and 700 feet above the valley floor, and the valley floor is about 2,000 feet above sea level. The breadth of this zone is about 400 feet. It follows up the smaller tributaries of the river, and in the higher valleys, where the valley floor is 3,900 feet above sea level, the verdant zone lies between 4,000 and 4,100 feet. It is said that within this zone frost never injures vegetation and the tenderest grapes never fail to produce abundant crops. A similiar zone is found in Polk county, North Carolina, on the flank of the mountain spur adjacent to the valleys of the Blue Ridge.

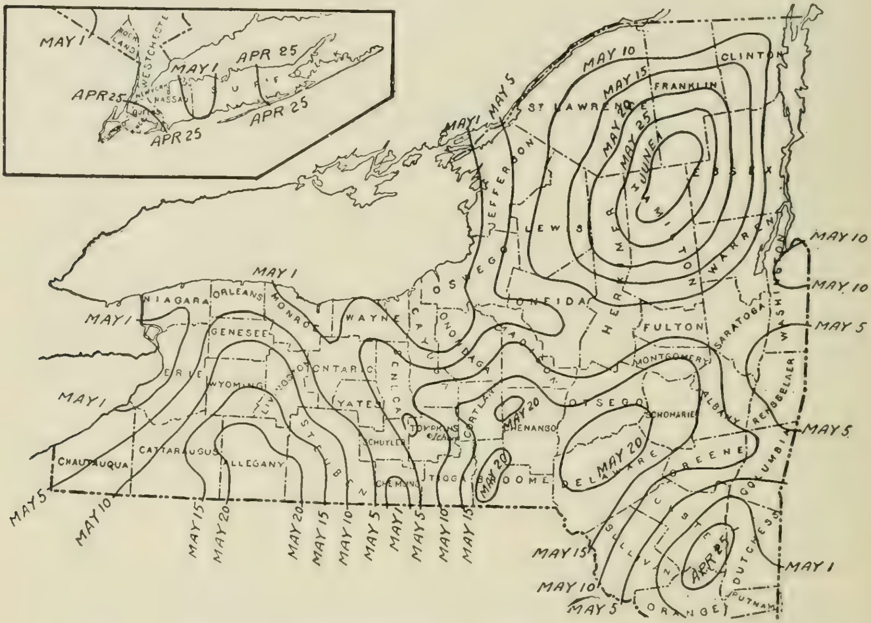

FIG. 139.—*Average date of last killing frost in spring*

This phenomenon is easily explained; it is due mainly to the fact that the outlet and slope of the valley are not sufficient to carry off, as rapidly as it accumulates, the cold air that slides down the mountain sides. Thus, the depth of the cold air in the valley increases as the night goes on, for the same reason that water rises in and fills a valley when a dam is thrown across its outlet. Now the warmer air, being lighter, floats on the surface of the colder air that fills the valley, and, coming in contact with the surface of the mountain sides, yields up its heat to the vegetation and thus gives immunity from frost. The upper limit of the verdant zone probably depends on the strength of the wind and the general temperature of the free air.

The effect of air drainage on frost conditions is often quite as marked where the differences in elevation are much less than in the foregoing examples. The so-called frost island, discovered by Winchell in the southeastern part of Michigan, is really the bottom of a depression into which the cold air settles. The surrounding elevated lands are much freer from frost, though the difference in elevation is small.

The lesson to be learned from these facts is that tender crops which are liable to injury by frost should not be planted on low lands, particularly when there is no outlet through which the cold air may drain away. A low hill or a gently sloping hillside somewhat above the valley floor is to be preferred as a location for an orchard or a garden. Just how high one should go on the hillside can be determined usually by careful observation of frosts for a single season. So much depends on the lay of the land and the grade of the slope that no rule can be given which will apply in all cases. With due regard to the foregoing principles of air drainage, experience and careful observation are the best guides.

EXPOSURE

In the latitude of New York State, hillsides exposed toward the south are warmest; next come those facing east, then west, and finally north. Liability to frost follows in the reverse order, being greatest on the north side. It is pointed out, however, that the fact that frost is less likely to occur with a southern exposure is not sufficient reason of itself for choosing the south side as a location site for an orchard, for the higher temperature on that side brings the blossoms out at an earlier date than on the north side; hence, a frost may kill the crop on a southern slope before the buds on a northern slope are in condition to be injured. On the other hand, the argument is advanced that when the trees on both sides are in bloom, the greater amount of heat stored in the soil on the warmer side may be sufficient to ward off a frost that would kill the crop on the colder side. There are numerous observations to show the temperature of the air and soil for the different exposures, but there are none known to the writer that tend to show the comparative value of the various exposures with respect to injury from frost when the difference in date of blooming is considered.

It appears that a majority of fruit growers in this State consider the northern exposure preferable, believing that the retarding of the date of blooming, due to the lower temperatures of the northern slope, more than compensates for the greater freedom from frost on the southern slope.

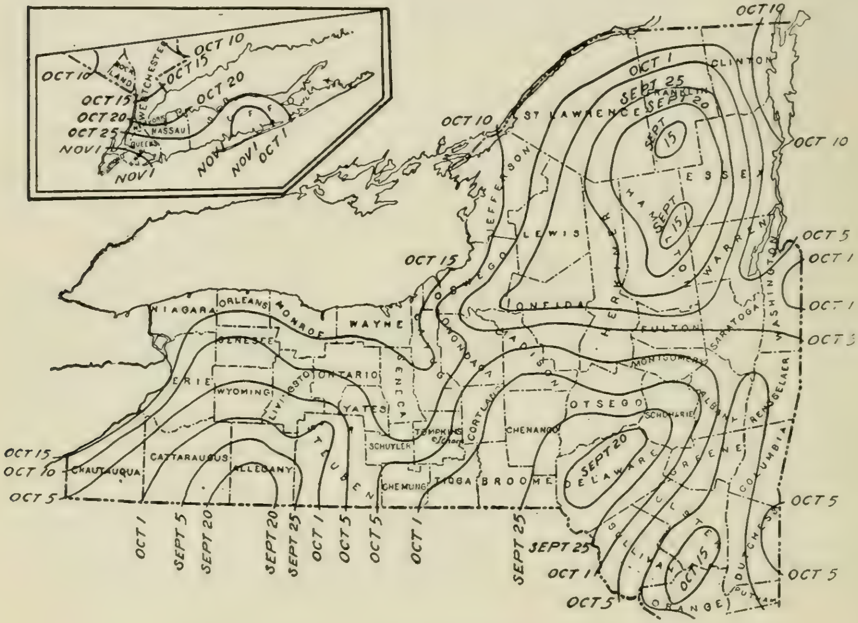

Fig. 140.—*Average date of first killing frost in fall*

EFFECT OF SOIL AND SOIL COVERING ON FROST

In investigating the conditions under which frost occurred in the cranberry districts of Wisconsin, the writer found that old cranberry bogs covered with a thick carpet of dried vines were much more liable to frost than were bogs more recently planted. It was believed that the thick covering of vines prevented a large part of the heat received from the sun during the daytime from reaching the soil, and, since but little heat was stored up by day, only feeble resistance was offered to the fall of temperature at night.

In the Cape Cod cranberry marshes it is the practice to spread about half an inch of sand over the surface of the marshes each year, thus covering the dry vines and furnishing a reservoir for the storage of heat received by day against the low temperatures at night.

Professor Cox made a series of observations on the temperature of the air over peat and sanded bogs five inches above the surface at Cranmoor, Mather, and Berlin, Wis., of which he says:

> For two months the (night) temperature over the sanded bog averaged higher than over the peat bog, as follows: Cranmoor, 5.3°, Mather, 4.4°, and Berlin, 5.4°; the greatest daily difference was 11° at Cranmoor on August 30 and at Mather on September 15, and 19° at Berlin on August 11. At no time did the minimum temperature over peat register higher than over sand at any one of the three stations. There were several dates, however, when there was no difference in the readings of the instruments over the peat and over the sand. This occurred invariably on cloudy nights when the temperature was high and there was no danger from frost.

Dewey A. Seeley, in investigating the effect of surface covering on temperature at Peoria, Ill., exposed four minimum thermometers as follows: No. 1, about half an inch below the surface of bare ground; No. 2, on the surface of bare ground; No. 3, half an inch below the surface of sod; No. 4, on the surface of sod. The four instruments were read on eighteen mornings after clear, quiet nights, also on thirteen afternoons when the weather was clear and the wind light. The results obtained were as follows:

	Average temperatures	
	Morning	Afternoon
No. 1, half inch below bare ground	30.1°	46.2°
No. 2, on surface of bare ground	27.3	45.0
No. 3, half inch below sod	36.2	47.9
No. 4, on surface of sod	23.9	43.0

Mr. Seeley calls attention to the fact that, although the soil under sod was warmest at night, its surface was coldest, the difference being surprisingly large, 12.3°, within the distance of about one inch between the two thermometers. This seems to indicate that comparatively little heat escapes through the sod covering at night, and that the loss of heat from the surface of the sod is very great. It is pointed out also that the temperature over sod was 3.4° below the temperature recorded over bare ground, indicating that the heat given off by the bare ground during the night was effective in raising the temperature of the air in contact with the surface. Mr. Seeley also found that the temperature of the air over soil that had been tilled recently averaged about 2° higher than that over similar soil that had not been cultivated for some time, and suggests the advisability of thorough tillage as a measure tending to protect against the effect of frost.

Professor Cox found that poorly drained cranberry bogs were much more liable to frost than those that were well drained, the average night temperature over poorly drained soils being 2.4° below that over the drier soils. In one instance the lack of proper drainage resulted in a total loss of the crop in the wet sections of the marsh, where the temperature fell to 27.3°; while in the drier sections the berries were unharmed, the lowest temperature being 35.8°. The relatively low temperatures over wet soils undoubtedly are due to excessive evaporation during the daytime, which uses up heat that over drier ground would go to raise the temperature of the soil, so that when night comes there is little heat in the soil to resist the fall in temperature.

The foregoing facts seem to show very clearly that the farmer who gives attention to proper cultivation and drainage will obtain not only the advantage of larger yields, but a certain immunity from frost as well.

FROST WARNINGS ISSUED BY THE UNITED STATES WEATHER BUREAU

It is entirely possible to forecast the occurrence of frost with a reasonable degree of accuracy twelve to twenty-four hours in advance. It is possible, also, to protect from frost to a limited degree. Nevertheless, so far as the general farmer is concerned, unless he is prepared to protect his crops when frost comes, frost warnings, however accurate, are of no practical value to him.

Modern methods of protection, while eminently practical, involve a considerable outlay of time and money, and in general farming the area to be protected is so large that the expense in practice is prohibitive. However, there are occasions when a warning of frost twenty-four hours in advance can be used to considerable advantage. In the sugar districts of Louisiana it is desirable that the cane remain standing as long as possible, because of the rapid increase of its sugar content toward the time of maturity. However, it must be cut before frost or there is great loss. It is the practice of the cane growers to make everything ready, and when a warning that frost threatens is received large quantities of cane are cut in a single day.

The writer knows of several instances when farmers in Wisconsin made a similar use of the frost warnings of the Weather Bureau and cut large acreages of corn, thus saving it from injury. It would seem that in a State like New York, where the season is none too long to mature corn and where every additional day that the crop stands increases its feed value, and with machinery in general use by which a large acreage may be cut in a few hours, warnings of frost might be used to great advantage.

Again, the farm orchard and garden usually are small in area and the cost of their protection by some of the simpler methods described further on would be slight compared with the returns from protection for a single night at a critical time.

Frost warnings are issued by the United States Weather Bureau generally about 10 a. m. eastern time. Occasionally, when conditions seem to warrant it, they are issued at other hours. The warnings are telegraphed to telephone exchanges, which will give the information to their patrons; so that almost any farmer who has a telephone may get the warnings by calling his exchange at 11 a. m. or shortly after. The warnings are distributed by mail, also, and are published in the newspapers.

It must be remembered that these warnings are general in character and cover a large territory. They apply to the average conditions over the territory and not specifically to the individual farm, which, because of its topography or the condition of the soil, may vary greatly from the general average in its liability to frost. Hence, the farmer who expects to obtain the greatest benefit from the warnings should accept them as applying generally to his vicinity, and should make such modification in their application to his own farm as a careful and intelligent study of local conditions seems to warrant.

FORECASTING FROST FROM LOCAL OBSERVATIONS

In the present state of knowledge it is hardly possible for one, no matter how well versed in the science of the weather he may be, to forecast frost with a fair degree of accuracy twenty-four hours in advance from observations made at a single place. The frost warnings issued by the United States Weather Bureau are based on several hundred observations taken in all parts of the United States and in Canada. However, local observations are indispensable to an intelligent use of the general warnings and may be made the basis of a fairly accurate judgment for a shorter period than twenty-four hours. Assuming that it is the season when frosts are likely to occur, the points to be considered, aside from local topography, are as follows:

1. Character of the preceding weather
2. State of the sky, whether cloudy or clear
3. Direction and force of the wind
4. Trend of the temperature
5. Atmospheric pressure

Preceding weather

The character of the preceding weather is important because damaging frosts often follow an abnormally warm period. The weather moves over the country from west to east in somewhat irregular, but nevertheless well-defined, waves. Hence, there is a strong tendency for extremes to follow each other, and such extremes are often disastrous in their effects. A light frost, particularly in spring, following an unusually warm period often will cause more damage than a severer frost preceded by cooler weather, because the warm weather forces out the blossoms prematurely and renders them more susceptible to injury. While an unusually warm period does not mean always that frost will follow, yet the fact that most frosts do follow such periods should be regarded as sufficient warning that frost is likely to occur.

State of the sky

Frost is not likely to occur when the sky is overcast because the heat given off by the earth at night does not penetrate the clouds easily and is practically all retained in the air below them, which therefore remains at a comparatively high temperature. Even a hazy condition of the sky, or the thinnest cirrus clouds, have an appreciable effect in retarding the fall of temperature at the surface. But on clear nights the heat escaping from the earth passes away quickly, almost without hindrance, far beyond the limits of the atmosphere. Hence, the fall of temperature at the surface is rapid and, unless the earth has a vast store of heat, frost is likely to occur.

Direction and force of the wind

The direction of the wind is a reliable indication of the approach of colder weather. If, after a day or two of warm southerly winds and possibly rain, the wind changes to the southwest or west, it is an almost unfailing indication that the warm spell is over, and it is well to watch closely the conditions that follow, particularly if there are signs of clearing weather. Occasionally, a frost follows when the wind backs from east or northeast to north or northwest. In either case, the conditions to be looked for as soon as the wind changes are falling temperature, decreasing wind, and a clear sky. Frost is not likely to occur unless the air becomes quiet and the sky clear, for wind prevents the accumulation of the colder air at the surface.

Trend of the temperature

The rate of fall in temperature during the late afternoon or early evening is a good indication of the lowest temperature that will be reached during the night. For example, a temperature of 40° at about 6 p. m., with a clear sky and light wind, is considered critical; particularly is this the case if the rate of fall approximates 1° for each two hours, which, if continuous — as would be likely with a clear sky and light wind — would bring the temperature close to the freezing point by early morning. A fall in temperature of 2° per hour would indicate frost, even with the temperature considerably above 40° in the late afternoon.

Atmospheric pressure

The rate of change in the pressure of the atmosphere as indicated by the barometer is of some assistance in forecasting frost. The actual stage of the pressure, whether above or below normal, is not important, except that a warm period with unusually low pressure is likely to be followed by the opposite extreme. The important factor is the rate of change. If the pressure is increasing rapidly, as indicated by a rapid rise in the barometer, it is a good indication that the cold period or cold wave is approaching rapidly. The change in pressure usually precedes by a short interval the change in direction of the wind, because the wind depends on the pressure; but one will have to watch the barometer very closely to gain much advantage over the indications afforded by the direction and force of the wind.

THE EVENING DEW-POINT AS A GUIDE TO THE MINIMUM TEMPERATURE OF THE FOLLOWING NIGHT

Recently there has been considerable discussion as to the value of the evening dew-point as indicating the probable fall in temperature during the ensuing night, and in order to gain a clear understanding of this question it seems necessary to review briefly the subject of atmospheric moisture and the principles involved.

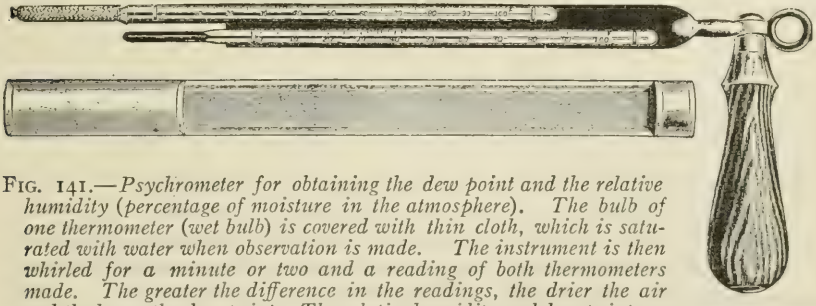

FIG. 141.—*Psychrometer for obtaining the dew point and the relative humidity (percentage of moisture in the atmosphere). The bulb of one thermometer (wet bulb) is covered with thin cloth, which is saturated with water when observation is made. The instrument is then whirled for a minute or two and a reading of both thermometers made. The greater the difference in the readings, the drier the air and the lower the dew point. The relative humidity and dew point are found by reference to tables that accompany the instrument.* *Price, $4 to $6*

There is always more or less moisture in the air in the form of vapor. The moisture gets into the air because the heat of the sun is always changing the water on the earth into vapor. To change a pint of water into vapor requires a little more heat than would raise the temperature of five pints of water from the freezing to the boiling point. Conversely, the vapor in the air always may be changed again into water if the temperature be sufficiently lowered, and when so changed the heat used originally to evaporate the water is released, or "liberated," and becomes available to warm the air, just as addition of heat from any outside source may do.

The dew point is the temperature at which the change from vapor to water begins, and is, therefore, the temperature at which the release of heat begins also. On these facts is based the belief that if the dew point is above freezing, the addition of heat to the air as dew continues to form — for dew is the result of change from vapor to water — will check, or at least retard, the fall in temperature and thus tend to prevent frost. On the other hand, if the dew point is below freezing, no retarding effect can be expected until the formation of frost has taken place. Thus, the dew-point temperature during the early evening, because it shows the temperature at which the release of heat may be expected to begin, has been considered a reliable guide to the lowest temperature of the following night. That its value as a guide in forecasting frost depends on general climatic conditions and varies widely in different parts of the country, seems to be borne out by the experience of a number of observers. O'Gara, in his work on "The Prevention of Frost Injury in the Orchards in the Rogue River Valley" (near Medford, Oreg.), found that there was a very close relation between the afternoon dew-point and the lowest temperature during the ensuing night. On ten clear, quiet nights when frost was likely to occur, the average evening dew-point was 34.7°, while the average of the ensuing minimum temperatures was 34.5°. The greatest difference on any night was 3° and there were several times when the evening dew-point and the following minimum temperature were the same. He considers the afternoon dew-point not only a reliable indication of whether or not frost will occur, but also a valuable guide as to the degree of frost.

Professor Cox, in his investigation of frost in the cranberry districts of Wisconsin, found that the early evening dew-point afforded "no indication whatever" of the ensuing minimum temperature. At the experiment station at Mather, Wis., during the month of September, 1907, the average dew-point temperature at 6 p. m. was 56.3° and the average of the following minima was 46.6° — an average difference of 9.7°. The variation for the different days of the month ranged from 0° to 28°; on thirteen nights the difference was 10° or more and there was only one night when the evening dew-point and the following minimum were the same. On every night throughout the month the evening dew-point was several degrees above freezing, so that in every case the effect of the liberation of heat from condensation was operative, yet frost occurred several times. On the 25th the dew point was 40°, yet in spite of the heat released by the process of condensation the temperature fell to 25° before morning. On the 30th the dew point at 6 p. m. was 49° and a minimum of 21° was experienced during the night following — a fall of 28° from the evening dew-point, notwithstanding the continuous liberation of latent heat. It cannot be doubted that heat was liberated in the process of condensation and that it had a warming effect, but in the cases cited the amount obviously was too small to have an appreciable influence in checking the fall of temperature.

Professor Willis I. Milham, of Williams College, Williamstown, Mass., conducted a series of observations covering a period of ten years. He found the condition of the atmosphere at Williamstown with respect to moisture almost exactly the reverse of that found by Professor Cox in the cranberry districts of Wisconsin. In the cranberry districts the evening dew-point nearly always was much above the ensuing minimum temperature, so that the effect of the liberation of heat nearly always was operative. At Williamstown the evening dew-point was generally lower than the minimum reached during the following night, and, in consequence, there was no liberation of heat to retard the fall of temperature. Professor Milham summarizes his conclusions as follows:

> 1. The cool nights of spring, when a frost might be expected, are very dry and the dew point lies so low that it plays practically no part in determining the minimum temperature.
>
> 2. The amount of the drop from the maximum to the following minimum is very far from constant, even if the characteristics of these nights seem very nearly the same.

An examination of observations for the months of April, May, September, and October for several years, made by cooperative observers in this State, shows that practically the same conditions exist here as were found by Professor Milham at Williamstown. In this State, however, the dew-point observations were made late in the evening, at 9 p. m., but the difference in time is not considered important. If there is any advantage it should be in favor of the later observations. In many cases examined, the air at the time of observation was saturated or nearly so, so that the liberation of heat began as soon as the temperature commenced to fall; but on clear nights when frost was probable, the air was often so dry that the dew point was several degrees below the freezing point, and therefore no effect from the liberation of heat could be expected. Moreover, the difference between the dew point at 9 p. m. and the ensuing minimum varied greatly. At Alfred, N. Y., in April, 1892, the difference ranged from 0° to 21°; on fourteen days the 9 p. m. dew-point was higher than the following minimum and on fifteen days it was lower. The following table of days when the minimum dropped to freezing or below at Alfred in April, 1892, will serve to illustrate the variation and is considered typical of the conditions found elsewhere:

Date	Air temperature 9 p. m.	Dew point 9 p. m.	Ensuing minimum	Minimum above (+) or below (—) dew point
5	64	52	31	—21
8	35	32	22	—10
23	46	41	26	—15
26	40	20	28	+ 8
30	40	30	38	+ 8

It is noticed that on the first three dates the ensuing minimum was much below the evening dew-point, and, although the liberation of heat must have been continuous, the fall of temperature apparently was checked but little if any. In the two remaining instances the minimum did not fall to the evening dew-point by a margin of 8°, which means that no heat was liberated and therefore no check was offered to the fall of temperature. In three of the five cases the cause that was expected to check the fall of temperature was operative, but apparently ineffectual, while in two cases it was not in operation even.

From the foregoing, it is apparent that this method of determining the probability and degree of frost is by no means so reliable or so general in its application as has been supposed heretofore.

For the farmer who is prepared to make practical use of a frost warning, the forecasts issued by the Weather Bureau should receive first consideration because they may be obtained early in the day, before it is possible to obtain any reliable indications from local observations as to the probability of frost. But when the warnings issued by the Weather Bureau cannot be obtained and the farmer must rely on himself, there are no instrumental readings that will take the place of a careful observation of the condition of the sky, the direction and force of the wind, and the trend of the temperature.

METHODS OF FROST PROTECTION

The object sought in all methods of frost protection is to hold the temperature of the air in contact with the plant above the point of danger. In the attempt to accomplish this certain principles are involved:

1. Prevention or retardation of the escape of heat from the earth by the use of an artificial covering. The use of smudges as a means of protection against frost is based on this principle.

2. Addition to the air of moisture in the form of vapor, with the view of obtaining the effect of liberation of latent heat as the moisture condenses. The use of damp fuel for smudges and the spraying of fires with water have this purpose in view.

3. Heating the air by numerous small fires.

Artificial covering

It is a very old practice to protect plants from frost by covering them with newspapers, carpets, straw, and the like. This is a most cleanly and efficient method, but unfortunately, because of the labor and expense involved, it is applicable in practice only to small areas, such as flower beds and gardens. However, by a small investment in tarred building paper the practice may be extended profitably to considerable areas. When the paper is cut into convenient lengths and two or three strips are fastened or pasted together so as to make a strip eight or ten feet wide, which can be rolled and unrolled easily, this method may be used for the protection of a fairly large area. It affords a very convenient and efficient protection for strawberries, garden truck, or small fruits. Paper of this kind can be purchased for one to two cents per square foot, and with care should last several years.

Smudging

Smudging, particularly when damp fuel is used, combines the first and second principles mentioned above — the prevention of the escape of heat from the ground and the addition of moisture to the air. In practice smudging has not proved a very efficient method of protection. It is used chiefly at present to shield the blossoms from the sun during the morning hours following a frost, thus preventing too rapid thawing. Spraying the frozen fruit or blossoms with water is practiced, also, with the same purpose in view. It is not so much the freezing that causes injury, as too rapid thawing. It is said that blossoms may be frozen solid for several hours without injury if thawed very slowly.

Heating the air

The most practical, efficient, and economical method yet devised for protection of large areas is the direct addition of heat by means of numerous small fires properly distributed over the area to be protected.

For the farmer who desires to protect the farm orchard, this method is offered as neither difficult nor expensive. However, it does require foresight and careful preparation. The fuel to be used must be on the ground and ready for instant use. Moreover, it must be dry, so that fires may be started quickly when the temperature approaches the point of danger. A small investment in an alarm thermometer will obviate the inconvenience of remaining up at night to watch for the time when the fires must be started. These thermometers are constructed to ring an alarm bell when the temperature approaches the danger point. The alarm thermometer should be located in the coldest part of the orchard and set to ring the bell when the temperature is still a few degrees above the point of danger, so as to give time to get the fires started.

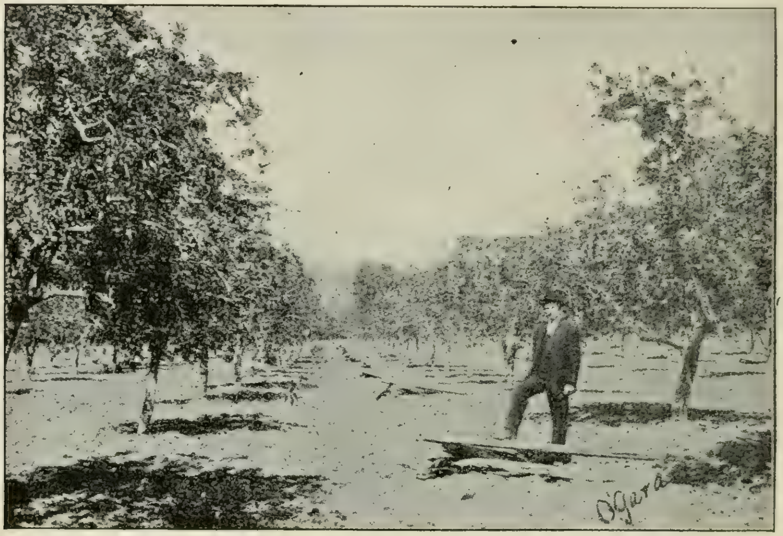

FIG. 142.—*Orchard owned by J. G. Gore, Medford, Oreg. Crop, valued at $1,000 per acre, has been saved four years in succession by the use of old rails for fuel purposes*

Wood, coal, and oil are the fuels in use, and the choice must depend on local price and supply.

Wood.—For the general farmer in New York who wishes to protect merely the farm orchard, open wood fires probably are the most economical.

The prunings from the ordinary orchard generally are not sufficient, but they should be saved and kept dry for use in starting the fires. Old rails or cordwood make good fuel, and when piled dovetail fashion, with a little dry kindling at the bottom, are easily lighted. J. G. Gore of Medford, Oreg., saved his crop, valued at $1,000 per acre, four years in succession by the use of old rails for fuel.

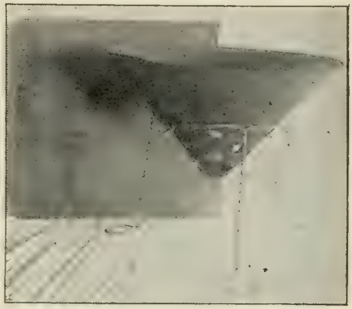

FIG. 143.—*Coal heater*

A little dash of kerosene or crude oil and the application of the torch is all that is necessary to light the fires. An iron rod three or four feet long, wound at one end with cotton waste or rags and saturated with oil, makes a serviceable torch.

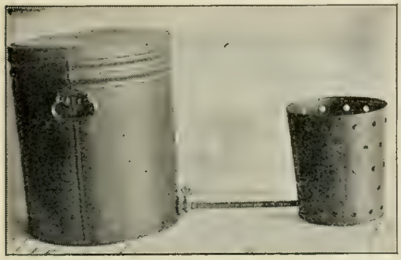

FIG. 144.—*Richardson reservoir heater*

The number of wood fires necessary to protect an orchard of large trees ranges from twenty-five to fifty per acre, depending on the degree of frost and the strength of the wind. The fires should not be large, since large fires tend to set up currents that draw in the cold air outside and thus may defeat the purpose in view. In practice it is best to prepare the maximum number, but to light only every other one at first, holding the others in reserve in case the fall of temperature is not checked. Usually it is possible to hold the temperature in an orchard in this way 6 to 10° above the temperature outside. It sometimes happens that even this is not sufficient and that some of the blossoms will be frosted, particularly in the colder parts of the orchard. When this occurs it is good practice to use the fires to create a dense smudge about sunrise, with a view of retarding the process of thawing. For this purpose coarse manure, sawdust, wet straw, and the like, may be used.

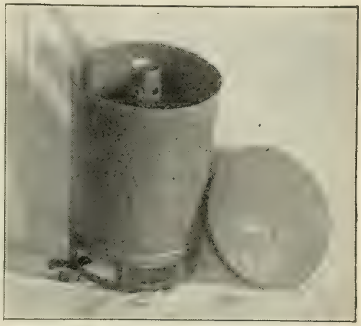

FIG. 145.—*Troutman heater*

Coal.—Coal makes an excellent fuel and in some instances is cheaper than wood. The use of wire baskets suspended from the trees or from tripods placed between the rows generally has been discarded, because the baskets will not retain their shape when heated. The most satisfactory coal burner is an inverted cone made of sheet iron perforated at the bottom for draft and holding perhaps half a bushel of coal. It is placed a few inches above the ground and supported on iron legs. The coal burners should be prepared in advance, so as to be lighted quickly when the temperature approaches the danger point. From twenty-five to fifty heaters per acre usually are considered sufficient for the ordinary orchard of medium age, but for young orchards the number should be increased. A medium grade of soft coal makes a satisfactory fuel, and twenty-five to thirty pounds per heater is sufficient for four hours burning. For the greater part of New York about $2 per night per acre, exclusive of labor in handling, probably would be the maximum cost of heating with coal.

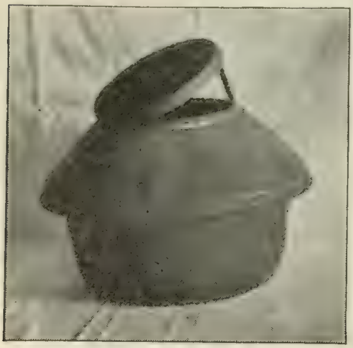
FIG. 146.—*Rayo orchard heater*

Oil.— For the commercial orchardist, oil is probably the most economical fuel, not because it is more efficient than wood or coal, but because it is more easily handled. Crude oil and distillate are used chiefly for this purpose. Crude oil is the cheaper, but is less satisfactory because it contains a certain percentage of water, which tends to extinguish the flame and causes the pots to boil over. Also, it is difficult to handle in cold weather and in burning it gives off large quantities of soot. Distillate is a by-product of crude oil remaining after the kerosene and gasoline have been extracted. It is free from water, ignites readily, burns freely, and leaves little residue. The question of an oil fuel that is satisfactory both in price and in efficiency is not yet settled.

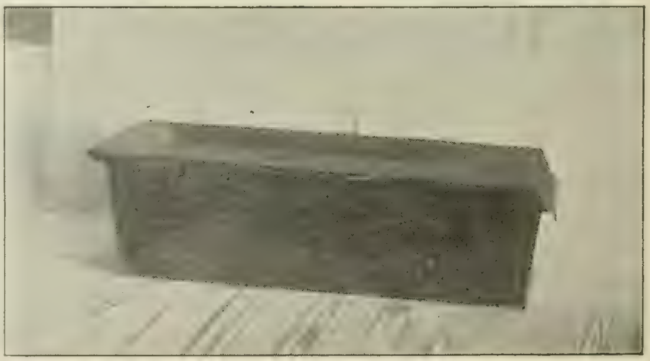
FIG. 147.—*Hamilton orchard heater. When in use the cover is partly withdrawn*

Probably more than fifty different styles of oil-burning orchard heaters have been placed on the market. Some are little more than a large lard pail, while others are fitted with soot arresters, feeds for controlling the flow of the oil, and various more or less complicated devices. Extensive field tests have shown that the simpler devices are quite as efficient as those of more complicated construction, are less likely to get out of order, and cost less.

Good practical heaters can be purchased in large lots for about 32 cents each. The number of heaters required per acre ranges from sixty for old orchards to one hundred for young orchards, old orchards with wide-spreading trees being less difficult to heat than young orchards. The cost of heating with oil (sixty heaters per acre), including cost of handling and interest on the investment, was found by O'Gara to be about $3 per night per acre. This was based on burning the heaters four hours per night, which is about the time necessary under average conditions.

WILL ORCHARD HEATING PAY IN NEW YORK?

In some parts of the country, particularly in the fruit-growing districts of the Pacific States, orchard heating is regarded as a necessity. In the commercial fruit-growing districts of New York the same necessity does not exist, because of an exceptionally favorable climate. This does not mean that frost protection in New York would be an unprofitable undertaking, but merely that fruit growing in New York is profitable in spite of occasional losses by frost. Every fruit grower carries a certain frost risk, which is a fixed charge against the crop. He may not have to settle the account this year or next, but the day of settlement is sure to come. The frost risk, even in the most favored parts of the fruit belts of New York, is greater than the risk of loss by fire, yet few farmers fail to insure against a loss of the latter character. Frost protection should be regarded as an insurance against loss by frost, and the cost of this kind of insurance is the cost of heating. Now, if it is possible to determine the annual frost risk and the average cost of heating per season, it is possible to determine whether or not orchard heating will be a profitable investment.

Hedrick says that during the past twenty-five years fruit was practically ruined by frost in western New York in four years — 1889, 1890, 1895, and 1902. In four other years — 1888, 1891, 1893, and 1903 — the damage was considerable; while in three years — 1892, 1896, and 1900 — the damage was slight and confined to early fruits. A careful examination of the temperatures during the blooming period in these years confirms his conclusions. This would indicate that the frost risk must be considerable.

Take, for example, an orchard located at Appleton, Niagara county, where the risk from frost is smaller, perhaps, than in most other parts of the State. An examination of temperatures at Appleton for the month of May in the past twenty years shows that temperatures occurred possibly in three, and certainly in two, years, that in all probability resulted in a total loss of crop. In 1890 the temperature fell to 27° on the night of May 9, and in 1902 to 26° on May 11. Damaging frosts occurred also in May in 1891, 1895, 1903, and 1907. (Fig. 149.) Assuming that the value of a normal crop in this orchard was $125 per acre, and that there was a total loss of crop in two years and a loss of one half the crop in four other years, the total loss in the twenty years would amount to $500 per acre, which is an annual loss of $25 per acre and represents the annual frost risk carried. In May in the past twenty years the temperature at Appleton fell to freezing or below (the lowest being 26°) thirty-four times, and, while a temperature of 32° is not necessarily injurious to orchard fruits, it indicates such a critical condition that a grower, if prepared, would not be justified in waiting longer before starting the fires.

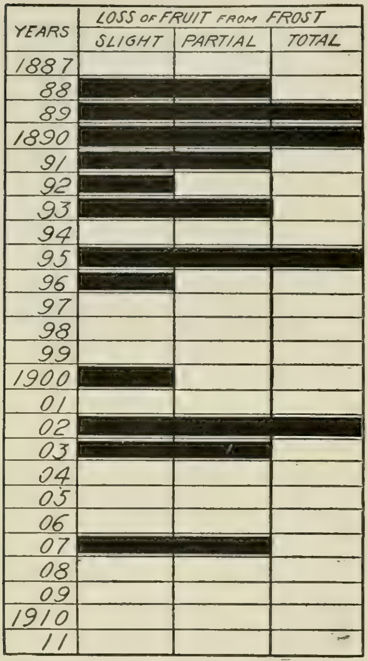

FIG. 148.—*Frost injury in western New York, twenty-five years, 1887 to 1911. A partial loss shown for 1907 is not included in Hedrick's statement*

Accepting O'Gara's experience of the cost of heating as $3 per acre per night, the total cost for the twenty years, heating thirty-four times, would amount to $102, or an annual cost of $5.10 per acre. This with the cost of the plant, $19.20 (60 heaters at 32 cents each), would make a total outlay the first season of $24.30. Thus, the risk for a single year, $25, would more than pay for the cost of the plant plus the cost of heating in the first season.

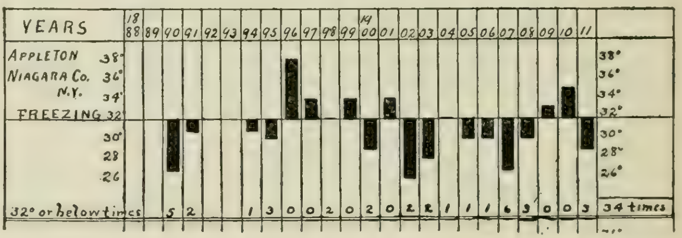

FIG. 149.—*Lowest May temperatures at Appleton, N. Y., with number of times freezing temperatures were recorded in each year. No record made in May, 1892, nor in May, 1893*

When orchard heating is undertaken extensively, tanks, hose, and other apparatus are necessary additional items of expense. But when it is remembered that a single outfit will take care of 15 or 20 acres, the expense per acre is very small. It is believed that the general farmer with only a small orchard, as well as the commercial fruit grower, would do well to consider orchard heating as a means of protecting against frost in the light of a profitable investment.

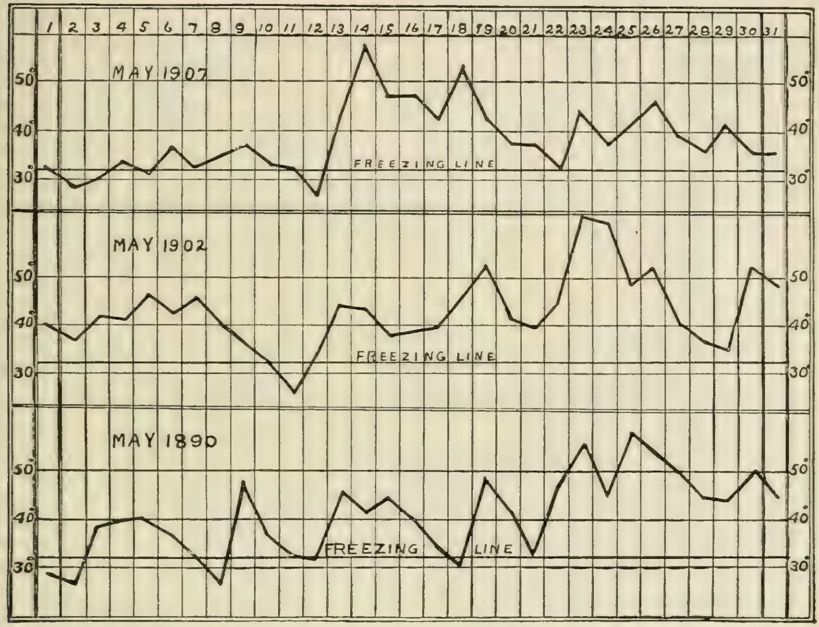

FIG. 150.—*Minimum temperatures at Appleton, Niagara county, for May, 1907, 1902, and 1890*

HOW TO OBTAIN INFORMATION ABOUT THE CLIMATE

The United States Weather Bureau, in cooperation with the New York State College of Agriculture, has on file the records of temperature, rainfall, sunshine, frost, and so on, made in nearly all parts of the State. All available information of this character may be obtained on application to The Section Director, Local Office, Weather Bureau, Ithaca, N. Y.

Similar information has been collected and is available for nearly every locality in the United States. Those who are contemplating the agricultural opportunities of any part of the country with whose climate they are not familiar would do well to consult these records. Records of this character are made under the supervision of the Weather Bureau and give the facts as they exist, without bias or color. Requests for information on the climate of regions outside of New York State, should be addressed to Chief of Weather Bureau, Washington, D. C.

FROST RECORDS IN NEW YORK AND THEIR APPLICATION

Arrangement of frost table

1. Alphabetically by climatic divisions
2. Alphabetically by counties under climatic divisions
3. Alphabetically by places under the county

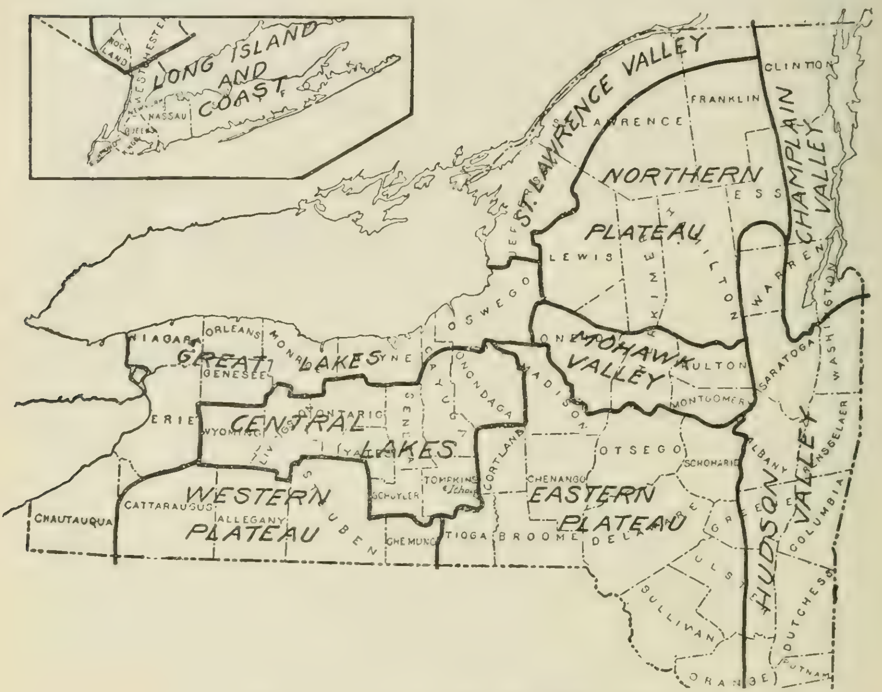

FIG. 151.—*Climatic divisions of New York*

The climatic divisions are as follows:

1. Central Lakes, pages 536–537
2. Champlain Valley, pages 536–537
3. Eastern Plateau, pages 536–539
4. Great Lakes, pages 538–539
5. Hudson Valley, pages 540–541
6. Long Island and Coast, pages 540–541
7. Mohawk Valley, pages 540–541
8. Northern Plateau, pages 542–543
9. St. Lawrence Valley, pages 542–543
10. Western Plateau, pages 542–543

Example — To find the frost record for Cooperstown, Otsego county:

By reference to the chart (Fig. 151) Otsego county is found in the Eastern

Plateau division, and the frost records for observation stations in the Eastern Plateau appear on pages 536–539 for spring and fall, respectively.

Explanation of table

The record given in each case covers the entire period for which authentic information is available. When no specific reference to killing frost was made in the record, the last occurrence of a freezing temperature in the spring and the first in the fall were considered as equivalent to killing frosts.

As an example, take the spring frosts at Auburn, Cayuga county, in the Central Lakes division (page 536). The data in the first four columns need no explanation. In the columns that follow, the figures represent the number of years in which the last killing frost in spring occurred within the dates given at the head of each column, which are five-day periods. In the column headed " 15 or before " under April, appears the figure 1, which means that there was one season in the 14 years of record when the last killing frost occurred on or before April 15. Under May, in the column headed " 1–5," is the figure 4, which means that in 4 out of the 14 seasons the last killing frost occurred between May 1 and 5, inclusive. The sum of the figures in the columns under May is 10, which means that in 10 out of 14 seasons killing frosts occurred after May 1.

The record of the first killing frosts in the fall is tabulated in a similar manner. The figure 1, in the column headed "21–25" under September, means that killing frost occurred within the five days, September 21 to 25 inclusive, in 1 out of 14 seasons. The sum of the figures in the columns preceding any date gives the number of seasons out of the years of record in which killing frosts occurred previous to that date. Thus, the sum of the figures preceding October 11 is 7, which means that killing frosts occurred before October 11 in 7 out of 14 seasons.

Practical application of frost records

The character of the seasons at a given place as shown by actual records of past years, is the best guide we have to the character of the seasons at that place in future years.

Consider, for example, the frost record of Wedgwood, Schuyler county (pages 536–537), with a view to determining the most favorable time for planting corn in that vicinity. By consulting the record of frosts at Wedgwood it is found that killing frosts occurred after May 20 in 5 out of 22 seasons, after May 25 in 1 out of 22 seasons, and that there were no killing frosts after June 1. If, during the 22 years, corn had been planted so as to be up on May 20 it would have been frosted in 5 out of the 22 years; if planted five days later, in 1 out of the 22 years; but if planted so as to be up on June 1 it would have escaped frost in all of the 22 seasons and the risk of frost in the spring would have been eliminated entirely. But fall frosts must be considered. Allowing eight days for germination, about 112 days are required to mature corn in this climate after it is up. From June 1 to September 15 is only 107 days, yet with so short a season as this the crop would have been frosted in the fall in 2 out of 23 years. Therefore it is evident in this case that the frost risk could not be eliminated wholly, and must be carried at one end of the season or the other. If, during the 22 years, the crop had been planted so as to be up on May 20, thus eliminating the fall risk, the spring risk would have been 5 out of 22, a rather heavy risk; if planted five days later, thus dividing the risk between spring and fall, the crop would have been frosted once in the spring and twice in the fall, a total of 3 times in the 22 years; but if planted late enough to escape the spring frosts, carrying the entire risk at the fall end of the season, it would have been possible to have made 20 crops in the 22 years without any injury from frost whatever. Moreover, since there were no frosts between September 15 and 20, a season of 117 days could have been obtained instead of 112 days without increasing the frost risk at either end of the season.

For any crop subject to injury from frost in either spring or fall it is possible in this way to determine the schedule that would have produced the best results in the past; and it is reasonable to assume that the crop scheme that was best in the past will prove best for the future also.

The frost record of a given locality should be of assistance as well in the selection of varieties that will be likely to mature in that locality. For example, the record for Baldwinsville shows that no frost occurred after June 1 in 18 years and in only 2 years before October 1. Thus, counting from the date of planting, May 22, a variety requiring 130 days to mature might be grown with a risk from frost in only 2 out of 18 seasons. At Wedgwood the risk for the same variety would be 5 seasons out of 23. At Shortsville, where no frosts have occurred in the fall before October 5 in 12 years, it would seem that a variety requiring 135 days to mature might be grown successfully.

It is understood that exigencies of soil or weather may at times interfere with any plan that may be devised; but the nearer the approach to the ideal in agricultural practice, which is the adaptation of the crop scheme to the climate, the better will be the results obtained.

In using the records given to determine the risk of injury by frost to tree fruits, it should be remembered that the records are based on temperatures taken mostly at a height of about four feet above ground; and for the reasons given on page 511, the risk of injurious temperatures at the height of the blossoms probably is considerably less than would appear from the tables. For example, the record made at Appleton, Niagara county, shows that freezing temperatures occurred after May 1 in 14 out of 21 years; but a careful study of the temperature record in detail, particularly in connection with the dates when the various fruits come into bloom (which always must be considered), warrants the statement that fruits in that vicinity were injured actually in only about 6 out of the 21 years, and in only two seasons did the injury approach a total loss. From this and other studies, it is believed that about one third the number of the frosts given in the table after any date in May will approximate the actual frost risk to which tree fruits are subject in a given locality.

LAST KILLING FROSTS IN SPRING

	Elevation	Years record	Average length of season (days)	Average date of last frost	Number of years last frost occurred within 5-day periods, ending with date at head of column										
					April				May						June
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
CENTRAL LAKES															
CAYUGA															
Auburn	715	14	161	May 5	1	0	1	2	4	1	3	0	2	...	....
Fleming	1,000	10	169	April 26	2	2	0	3	0	1	1	1	...	...	....
King Ferry	......	7	150	May 14	...	...	...	...	3	0	0	1	3	...	....
LIVINGSTON															
Avon	585	15	146	May 13	...	1	1	0	3	1	3	0	3	3	....
Hemlock Lake	900	14	167	May 3	1	1	1	2	4	3	1	0	0	1	....
Hunt	1,321	7	135	May 20	...	...	...	1	1	0	1	0	1	2	1
ONONDAGA															
Baldwinsville	385	18	168	April 29	5	0	3	3	2	0	2	0	2	1	....
Fayetteville	530	10	154	May 13	...	...	1	1	3	0	1	0	1	2	1
Syracuse	597	9	175	April 27	1	0	3	1	4	...	...	...	...	...	....
ONTARIO															
Shortsville	740	12	164	May 7	...	1	1	0	5	0	3	0	1	1	....
SCHUYLER															
Perry City	1,038	22	132	May 18	...	...	1	0	3	3	4	3	3	2	3
Wedgwood	1,430	22	155	May 5	1	1	0	2	3	2	5	3	4	1	....
SENECA															
Romulus	719	19	156	May 9	3	0	1	2	3	2	2	2	3	1	....
TOMPKINS															
Ithaca	928	32	159	May 4	3	1	3	3	8	5	5	0	2	2	....
YATES															
Penn Yan	750	6	167	May 2	1	0	0	1	1	1	2	...	...	...	....
CHAMPLAIN VALLEY															
CLINTON															
Chazy	151	9	148	May 10	...	...	2	1	2	0	0	0	4	...	....
Dannemora	1,490	6	141	May 16	...	...	...	...	3	0	0	1	0	1	1
Harkness	622	10	148	May 12	...	...	1	0	5	0	0	0	2	0	2
Plattsburg	125	20	156	May 8	1	1	1	4	5	0	3	2	1	1	1
ESSEX															
Ticonderoga	344	13	156	May 6	1	1	1	2	2	1	3	0	1	0	1
WARREN															
Lake George	350	14	150	May 9	...	...	1	2	3	2	2	1	3	...	....
WASHINGTON															
Carvers Falls	243	14	138	May 14	...	...	1	0	0	4	3	0	6	...	....
EASTERN PLATEAU															
BROOME															
Binghamton	875	21	154	May 16	1	2	4	0	3	2	3	2	3	1	.....
CHENANGO															
Norwich	1,015	5	148	May 10	...	...	...	1	1	1	0	1	1	...	.....
Oxford	938	22	132	May 17	...	...	1	0	1	4	3	3	5	4	1
CORTLAND															
Cortland	1,030	18	139	May 16	1	0	1	1	2	4	3	3	1	1	1

FIRST KILLING FROSTS IN FALL

	Elevation	Years record	Average length of season (days)	Average date of first frost	Number of years first frost occurred within 5-day periods, ending with date at head of column										
					September				October						November
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
CENTRAL LAKES															
CAYUGA															
Auburn	715	14	161	Oct. 13	...	...	1	0	2	4	1	2	2	2	....
Fleming	1,000	12	169	Oct. 12	1	0	0	2	1	1	2	3	0	1	1
King Ferry	......	7	150	Oct. 11	...	...	...	...	2	1	3	0	0	1	....
LIVINGSTON															
Avon	585	15	146	Oct. 6	2	0	1	1	5	1	1	2	1	1	....
Hemlock Lake	900	14	167	Oct. 17	...	...	...	...	2	2	2	3	2	3	....
Hunt	1,321	8	135	Oct. 2	1	0	1	1	2	1	1	1	...	...	....
ONONDAGA															
Baldwinsville	385	18	168	Oct. 14	1	0	1	0	2	4	3	1	2	2	2
Fayetteville	530	11	154	Oct. 14	...	...	1	1	0	1	3	1	2	2	....
Syracuse	597	9	175	Oct. 19	...	...	...	...	0	2	2	0	2	3	....
ONTARIO															
Shortsville	740	12	164	Oct. 18	...	...	...	...	0	2	2	3	2	3	....
SCHUYLER															
Perry City	1,038	22	132	Sept. 27	4	4	4	1	3	2	2	0	1	1	....
Wedgwood	1,430	23	155	Oct. 7	2	0	2	1	4	6	4	2	2	...	....
SENECA															
Romulus	719	22	156	Oct. 12	1	0	1	1	3	3	3	6	3	1	....
TOMPKINS															
Ithaca	928	33	159	Oct. 10	2	0	2	1	4	8	6	5	3	2	....
YATES															
Penn Yan	750	7	167	Oct. 16	...	...	...	...	2	1	0	1	1	2	....
CHAMPLAIN VALLEY															
CLINTON															
Chazy	151	9	148	Oct. 5	...	1	1	0	3	2	0	1	1	...	....
Dannemora	1,490	6	141	Oct. 4	...	...	1	1	1	1	2	...	...	...	....
Harkness	622	10	148	Oct. 7	1	0	1	0	2	3	0	1	2	...	....
Plattsburg	125	17	156	Oct. 11	...	...	1	2	2	6	1	3	2	...	....
ESSEX															
Ticonderoga	344	12	156	Oct. 9	1	1	0	0	2	4	0	2	1	1	....
WARREN															
Lake George	350	14	150	Oct. 6	2	0	1	0	2	5	1	1	2	...	....
WASHINGTON															
Carvers Falls	243	14	138	Sept. 29	2	3	2	1	1	2	1	1	1	...	....
EASTERN PLATEAU															
BROOME															
Binghamton	875	22	154	Oct. 17	1	2	2	3	2	3	4	3	1	1	....
CHENANGO															
Norwich	1,015	6	148	Oct. 5	1	0	0	0	2	0	2	1	...	...	....
Oxford	938	22	132	Sept. 26	6	2	3	4	2	0	4	1	...	...	....
CORTLAND															
Cortland	1,030	19	139	Oct. 2	2	1	2	2	4	4	2	2	...	...	....

LAST KILLING FROSTS IN SPRING

	Elevation	Years record	Average length of season (days)	Average date of last frost	Number of years last frost occurred within 5-day periods, ending with date at head of column										
					April				May						June
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
EASTERN PLATEAU (*Continued*)															
DELAWARE															
Griffin Corners........	2,260	11	115	May 24	...	...	...	...	...	...	2	2	3	1	3
South Kortright......	1,441	16	109	May 27	...	...	...	...	...	1	1	2	4	4	4
GREENE															
Windham............	1,520	12	130	May 17	...	...	1	0	2	1	0	2	3	2	1
MADISON															
Bouckville...........	1,350	14	142	May 8	2	0	0	0	2	2	4	1	2	1	....
De Ruyter...........	1,300	9	133	May 21	...	...	...	...	2	0	1	1	1	3	1
ORANGE															
Middletown..........	700	17	183	April 17	8	2	2	2	1	1	1	...	...	...	....
Port Jervis...........	470	22	162	May 1	1	2	3	5	4	3	2	2	...	...	....
Salisbury Mills.......	314	5	150	May 11	...	...	1	1	0	0	2	0	0	0	1
OTSEGO															
Cooperstown..........	1,250	21	148	May 8	...	1	2	4	2	0	5	3	3	1	....
New Lisbon..........	1,234	20	123	May 23	...	...	...	...	1	3	2	1	4	5	4
Oneonta.............	1,112	16	139	May 10	...	1	2	0	1	4	1	2	5	...	....
SULLIVAN															
Jeffersonville.........	1,240	8	134	May 16	...	...	1	0	1	1	1	0	1	2	1
Liberty..............	2,300	13	149	May 8	1	1	1	0	2	2	2	1	1	1	1
TIOGA															
Newark Valley........	825	4	128	May 24	...	...	...	...	...	...	...	...	4	...	....
Straits Corners.......	600	9	118	May 26	...	...	...	...	...	1	2	1	2	1	2
Waverly.............	824	19	135	May 15	...	...	1	0	2	4	3	2	2	5	....
ULSTER															
Mohonk Lake........	1,245	15	172	April 26	4	0	2	2	3	3	1	...	...	...	....
GREAT LAKES															
CHAUTAUQUA															
Jamestown...........	1,328	13	146	May 9	...	...	4	0	1	3	0	0	4	1	....
Volusia..............	1,167	12	153	May 8	...	...	2	0	4	2	2	0	1	1	....
Westfield............	867	15	172	May 2	1	1	2	0	5	3	2	0	1	0	....
ERIE															
Alden................	846	4	161	May 3	...	1	0	0	1	1	1	...	...	...	....
Buffalo..............	767	41	174	April 25	9	5	10	3	8	2	1	1	2	0	....
GENESEE															
Elba.................	500	12	156	May 6	...	1	1	0	5	2	1	1	1	0	....
Le Roy..............	920	12	152	May 7	...	...	1	3	3	0	2	2	1	0	....
MONROE															
Brockport............	537	16	168	May 2	1	1	1	3	5	0	4	1	0	0	....
Rochester............	523	20	175	April 25	7	0	3	3	2	0	3	0	1	1	....
NIAGARA															
Appleton.............	270	21	164	May 4	1	2	3	1	4	3	4	2	1	0	....
Lockport.............	650	20	168	April 30	4	1	2	3	4	0	3	2	1	0	....
ORLEANS															
Ridgeway............	......	10	167	May 4	0	2	1	0	2	2	2	0	0	1	....
OSWEGO															
Oswego..............	335	21	174	April 28	5	1	3	5	1	2	1	0	1	2	....
Palermo.............	460	10	144	May 6	2	0	0	1	0	2	1	1	1	1	1
WAYNE															
Lyons...............	426	17	175	April 25	4	2	2	3	2	1	3	0	0	0	....

FIRST KILLING FROSTS IN FALL

	Elevation	Years record	Average length of season (days)	Average date of first frost	Number of years first frost occurred within 5-day periods, ending with date at head of column										
					September				October						November
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
EASTERN PLATEAU (*Continued*)															
DELAWARE															
Griffin Corners	2,260	10	115	Sept. 16	5	3	0	2	...	...	...	...	...	...	....
South Kortright	1,441	17	109	Sept. 13	4	3	6	3	0	1	...	...	...	...	....
GREENE															
Windham	1,520	12	130	Sept. 24	3	2	1	2	2	2	...	...	...	...	....
MADISON															
Bouckville	1,350	15	142	Sept. 27	3	1	2	2	2	3	1	1	...	...	....
De Ruyter	1,300	9	133	Oct. 1	2	0	1	1	1	2	1	0	1	...	....
ORANGE															
Middletown	700	18	183	Oct. 17	...	...	1	0	2	1	2	4	5	2	1
Port Jervis	470	22	162	Oct. 10	1	0	1	3	2	2	4	2	6	1	....
Salisbury Mills	314	5	150	Oct. 8	...	1	0	0	0	1	2	1	...	...	....
OTSEGO															
Cooperstown	1,250	22	148	Oct. 3	3	2	3	2	2	3	3	2	2	...	....
New Lisbon	1,234	20	123	Sept. 23	5	3	3	6	0	0	1	2	...	...	....
Oneonta	1,112	18	139	Sept. 26	5	2	2	3	2	2	1	1	...	...	....
SULLIVAN															
Jeffersonville	1,240	9	134	Sept. 27	1	1	1	3	2	0	1	...	...	...	....
Liberty	2,300	12	149	Oct. 4	2	0	1	1	2	1	3	1	1	...	....
TIOGA															
Newark Valley	825	5	128	Sept. 29	1	0	0	0	3	1	...	...	...	...	....
Straits Corners	600	8	118	Sept. 21	2	2	2	1	1	...	...	...	...	...	....
Waverly	824	19	135	Sept. 27	5	2	2	2	1	3	1	1	1	1	....
ULSTER															
Mohonk Lake	1,245	15	172	Oct. 15	...	...	1	1	1	2	2	2	2	4	....
GREAT LAKES															
CHAUTAUQUA															
Jamestown	1,328	12	146	Oct. 2	1	0	3	2	2	2	0	1	1	...	....
Volusia	1,167	13	153	Oct. 8	...	...	1	3	0	4	3	2	...	...	....
Westfield	867	14	172	Oct. 21	...	...	...	...	1	1	3	1	3	4	1
ERIE															
Alden	846	5	161	Oct. 11	1	0	0	0	0	1	0	2	1	...	....
Buffalo	767	39	174	Oct. 16	...	...	1	3	3	8	5	4	5	8	2
GENESEE															
Elba	500	12	156	Oct. 9	1	0	0	1	1	3	3	2	1	...	....
Le Roy	920	13	152	Oct. 6	1	0	1	2	2	3	2	1	1	...	....
MONROE															
Brockport	537	15	168	Oct. 17	...	...	...	...	1	2	4	2	2	4	....
Rochester	523	21	175	Oct. 17	...	...	...	1	1	3	4	5	2	4	1
NIAGARA															
Appleton	270	23	164	Oct. 15	...	...	1	1	4	4	4	2	2	5	....
Lockport	650	20	168	Oct. 15	...	...	1	1	2	3	3	3	1	5	1
ORLEANS															
Ridgeway	......	10	167	Oct. 18	...	...	...	...	1	3	0	2	1	3	....
OSWEGO															
Oswego	335	21	174	Oct. 19	...	...	1	0	1	3	2	4	1	8	1
Palermo	460	11	144	Sept. 27	2	2	1	1	1	3	0	1	...	...	....
WAYNE															
Lyons	426	18	175	Oct. 17	...	...	...	...	2	3	2	6	3	0	2

LAST KILLING FROSTS IN SPRING

	Elevation	Years record	Average length of season (days)	Average date of last frost	Number of years last frost occurred within 5-day periods, ending with date at head of column										
					April				May						June
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
HUDSON VALLEY															
ALBANY															
Albany	97	21	176	April 24	6	1	4	3	4	0	3	...	...	...	....
West Berne	600	14	133	May 15	...	1	1	0	2	1	2	0	4	1	2
COLUMBIA															
Chatham	470	7	149	May 13	...	...	...	1	2	0	1	0	3	...	....
DUTCHESS															
Honeymeadbrook	450	11	154	May 4	1	0	2	1	1	4	1	0	1	...	....
Wappingers Falls	110	19	171	April 27	3	3	3	2	3	2	2	1	...	...	....
GREENE															
Athens	90	10	162	May 3	1	0	3	0	2	1	2	0	0	1	....
ORANGE															
West Point	167	14	182	April 20	5	1	4	2	0	2	...	...	...	...	....
PUTNAM															
Carmel	500	17	168	April 26	3	2	3	1	3	4	1	...	...	...	....
SARATOGA															
Ballston Lake	400	8	154	May 6	...	...	1	1	4	0	0	0	2	...	....
Greenfield Center	314	13	150	May 5	1	0	2	2	3	0	2	1	2	...	....
Spier Falls	400	9	139	May 8	...	...	1	1	4	0	1	0	1	1	....
WARREN															
Glens Falls	340	18	148	May 7	1	1	1	2	5	1	2	1	4	...	....
North Creek	1,002	4	131	May 17	...	...	...	...	1	1	0	0	0	1	1
WASHINGTON															
Greenwich	425	14	151	May 10	...	...	1	1	4	2	2	0	3	1	....
LONG ISLAND AND COAST															
NEW YORK															
New York	314	38	210	April 10	29	5	2	2	...	...	...	...	...	...	....
SUFFOLK															
Cutchogue	32	13	181	April 24	3	0	4	2	1	1	2	...	...	...	....
Setauket	40	22	206	April 16	12	3	5	0	0	0	0	1	0	1	....
Southampton	36	11	184	April 23	4	1	2	1	1	0	1	0	0	1	....
Wading River	112	6	168	May 7	...	...	...	1	2	2	0	0	1	...	....
WESTCHESTER															
Bedford	290	16	157	May 3	1	2	1	3	3	1	2	1	1	1	....
Mount Hope	200	14	170	April 27	1	2	5	2	1	0	2	0	1	...	....
Scarsdale	200	8	170	April 29	1	1	2	0	2	0	2	...	...	...	....
MOHAWK VALLEY															
FULTON															
Gloversville	850	20	139	May 10	1	0	1	3	3	3	3	0	4	1	1
HERKIMER															
Little Falls	924	15	156	May 4	1	1	1	2	4	2	3	0	1	...	....
Salisbury	1,526	15	125	May 19	...	...	...	...	1	2	4	1	2	3	2
MONTGOMERY															
Amsterdam	277	8	163	April 28	...	...	4	1	2	0	1	...	...	...	....
Fort Plain	316	7	152	May 10	...	...	1	0	3	0	1	0	1	1	....

FIRST KILLING FROSTS IN FALL

	Elevation	Years record	Average length of season (days)	Average date of first frost	Number of years first frost occurred within 5-day periods, ending with date at head of column										
					September				October						November
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
HUDSON VALLEY															
ALBANY															
Albany	97	21	176	Oct. 17	...	...	1	0	1	6	5	4	2	2	....
West Berne	600	13	133	Sept. 25	2	4	2	1	2	1	0	0	1	...	....
COLUMBIA															
Chatham	470	7	149	Oct. 9	1	0	0	0	2	1	2	0	1	...	....
DUTCHESS															
Honeymeadbrook	450	10	154	Oct. 5	1	0	1	1	1	2	0	3	1	...	....
Wappingers Falls	110	19	171	Oct. 15	1	0	1	0	1	2	4	4	3	2	1
GREENE															
Athens	90	10	162	Oct. 12	...	...	1	0	1	1	4	1	1	1	....
ORANGE															
West Point	167	14	182	Oct. 19	...	...	...	2	1	2	2	0	1	4	2
PUTNAM															
Carmel	500	16	168	Oct. 11	1	0	1	1	0	4	4	2	2	1	...
SARATOGA															
Ballston Lake	400	8	154	Oct. 7	...	...	1	1	1	3	1	0	0	1	...
Greenfield Center	314	14	150	Oct. 2	1	1	1	0	4	4	2	0	1	...	...
Spier Falls	400	10	139	Sept. 24	3	0	3	1	1	2	...	...	...	...	....
WARREN															
Glens Falls	340	19	148	Oct. 2	3	1	2	2	3	3	2	2	1	...	....
North Creek	1,002	4	131	Sept. 25	1	1	0	1	0	1	...	...	...	...	....
WASHINGTON															
Greenwich	425	14	151	Oct. 8	...	...	1	1	5	2	1	2	2	...	....
LONG ISLAND AND COAST															
NEW YORK															
New York	314	39	210	Nov. 6	...	...	...	...	...	...	1	0	4	8	26
SUFFOLK															
Cutchogue	32	13	181	Oct. 22	...	...	...	...	1	1	1	2	3	4	1
Setauket	40	23	206	Nov. 8	...	...	...	...	...	...	...	...	2	3	18
Southampton	36	11	184	Oct. 24	...	...	...	...	...	1	1	2	1	5	1
Wading River	112	6	168	Oct. 22	...	...	...	...	...	1	2	0	0	2	1
WESTCHESTER															
Bedford	290	17	157	Oct. 7	2	0	2	1	1	1	2	3	3	1	1
Mount Hope	200	14	170	Oct. 14	...	...	1	0	1	2	4	2	3	1	....
Scarsdale	200	8	170	Oct. 16	...	...	1	0	1	0	1	2	1	2	....
MOHAWK VALLEY															
FULTON															
Gloversville	850	20	139	Sept. 26	3	4	3	5	2	2	0	0	1	...	....
HERKIMER															
Little Falls	924	15	156	Oct. 7	2	0	1	1	3	3	1	1	1	2	....
Salisbury	1,526	15	125	Sept. 21	4	5	1	2	2	1	...	...	...	...	....
MONTGOMERY															
Amsterdam	277	9	163	Oct. 8	1	0	1	0	1	2	2	0	1	1	....
Fort Plain	316	7	152	Oct. 10	...	...	1	0	0	2	3	0	0	1	....

LAST KILLING FROSTS IN SPRING

	Elevation	Years record	Average length of season (days)	Average date of last frost	Number of years last frost occurred within 5-day periods, ending with date at head of column										
					April				May						June
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
NORTHERN PLATEAU															
ESSEX															
Keene Valley	1,000	14	118	May 24	...	...	...	...	1	0	2	3	1	2	5
Saranac Lake	1,620	14	114	May 22	...	...	...	...	2	1	3	1	0	1	6
South Schroon	1,225	6	119	May 20	...	...	1	0	0	0	0	0	3	2	....
FRANKLIN															
Gabriels	1,729	12	94	June 5	...	...	...	...	...	1	1	1	0	0	9
Tupper Lake	1,552	9	107	June 1	...	...	...	...	...	...	2	0	2	1	4
HAMILTON															
Indian Lake	1,705	12	84	June 12	...	...	...	...	...	...	...	1	0	1	10
North Lake	1,822	10	122	May 29	...	...	...	...	...	...	...	2	3	0	5
LEWIS															
Lowville	900	20	134	May 15	...	...	...	3	2	2	3	4	4	0	2
Number Four	1,571	15	112	May 22	...	...	...	...	1	1	3	2	3	1	4
ST. LAWRENCE VALLEY															
FRANKLIN															
Moira	200	12	142	May 13	...	...	1	2	2	0	2	0	3	1	1
JEFFERSON															
Adams Center	540	9	146	May 15	...	...	...	...	5	0	1	0	0	2	1
Cape Vincent	246	7	166	May 1	...	...	...	4	3	...	...	...	...	...	....
Philadelphia	435	5	144	May 14	...	...	...	1	2	0	0	0	1	0	1
Watertown	737	16	152	May 7	...	2	2	1	4	1	3	0	1	2	....
ST. LAWRENCE															
Canton	448	17	144	May 7	...	...	2	4	3	3	3	0	0	1	1
North Hammond	420	19	154	May 8	...	3	3	1	0	4	1	2	4	1	....
Ogdensburg	175	17	154	May 6	1	2	2	1	3	0	3	1	3	1	....
Potsdam	430	16	143	May 10	...	...	1	3	2	3	3	1	2	1	....
WESTERN PLATEAU															
ALLEGANY															
Alfred	1,976	14	133	May 15	...	1	1	0	2	3	0	3	1	1	2
Angelica	1,340	21	125	May 23	...	...	...	...	1	4	3	3	2	3	5
Bolivar	1,800	15	110	May 27	...	...	1	0	0	1	1	1	4	2	5
CATTARAUGUS															
Allegany	1,421	5	135	May 11	...	...	...	...	3	0	0	1	1	...	....
Franklinville	1,598	14	128	May 22	...	...	...	1	1	1	3	1	1	2	4
Humphrey	1,950	13	136	May 14	...	...	1	2	0	2	1	1	4	2	....
Otto	1,410	9	144	May 8	...	1	1	0	3	1	1	0	1	0	1
CHEMUNG															
Elmira	863	17	158	April 29	4	2	2	1	2	1	2	0	3	...	....
STEUBEN															
Addison	1,000	21	154	May 8	1	2	1	2	3	2	3	3	3	1	....
Atlanta	1,200	7	131	May 17	...	...	...	1	0	1	0	1	2	2	....
South Canisteo	1,480	19	122	May 22	...	...	1	0	1	2	2	2	4	2	5
WYOMING															
Arcade	1,770	11	125	May 24	...	1	1	0	0	0	2	0	2	2	3

FIRST KILLING FROSTS IN FALL

	Elevation	Years record	Average length of season (days)	Average date of first frost	Number of years first frost occurred within 5-day periods, ending with date at head of column										
					September				October						November
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
NORTHERN PLATEAU															
ESSEX															
Keene Valley	1,000	16	118	Sept. 18	8	2	2	1	2	0	0	1	...	...	....
Saranac Lake	1,620	14	114	Sept. 13	8	2	3	1	...	...	...	...	...	...	....
South Schroon	1,225	6	119	Sept. 16	3	1	2	...	...	...	...	...	...	...	....
FRANKLIN															
Gabriels	1,729	10	94	Sept. 7	8	1	0	0	0	1	...	...	...	...	....
Tupper Lake	1,552	9	107	Sept. 16	5	1	0	2	0	0	1	...	...	...	....
HAMILTON															
Indian Lake	1,705	11	84	Sept. 4	10	0	0	0	1	...	...	...	...	...	....
North Lake	1,822	11	122	Sept. 28	2	0	2	2	3	0	1	1	...	...	....
LEWIS															
Lowville	900	21	134	Sept. 26	4	4	3	4	2	1	1	1	1	...	....
Number Four	1,571	16	112	Sept. 11	3	4	6	1	0	1	1	...	...	...	....
ST. LAWRENCE VALLEY															
FRANKLIN															
Moira	200	12	142	Oct. 2	1	2	1	0	4	1	1	2	...	...	....
JEFFERSON															
Adams Center	540	11	146	Oct. 8	1	0	1	1	1	2	2	1	2	...	....
Cape Vincent	246	7	166	Oct. 14	...	...	...	...	...	3	1	1	2	...	....
Philadelphia	435	5	144	Oct. 5	1	0	0	0	1	1	1	1	...	...	....
Watertown	737	17	152	Oct. 6	1	0	2	0	4	3	1	3	0	3	....
ST. LAWRENCE															
Canton	448	17	144	Sept. 28	2	2	4	1	4	3	0	1	...	...	....
North Hammond	420	17	154	Oct. 9	2	0	1	0	1	7	1	3	1	0	1
Ogdensburg	175	19	154	Oct. 7	1	1	1	3	3	4	1	4	1	...	....
Potsdam	430	17	143	Sept. 30	2	0	4	3	3	2	2	1	...	...	....
WESTERN PLATEAU															
ALLEGANY															
Alfred	1,976	13	133	Sept. 25	3	0	3	3	3	1	...	...	...	...	....
Angelica	1,340	22	125	Sept. 25	6	1	4	5	2	2	1	0	0	1	....
Bolivar	1,800	13	110	Sept. 14	8	1	1	2	1	...	...	...	...	...	....
CATTARAUGUS															
Allegany	1,421	5	135	Sept. 23	1	1	0	1	0	1	1	...	...	...	....
Franklinville	1,598	14	128	Sept. 27	3	3	1	3	0	2	0	2	...	...	....
Humphrey	1,950	14	136	Sept. 27	3	0	2	4	3	1	1	...	...	...	....
Otto	1,410	8	144	Sept. 29	3	0	0	1	0	2	0	1	1	...	....
CHEMUNG															
Elmira	863	16	158	Oct. 3	1	1	3	1	2	5	2	0	0	1	....
STEUBEN															
Addison	1,000	22	154	Oct. 9	2	0	2	3	4	3	2	2	1	3	....
Atlanta	1,200	7	131	Sept. 25	2	1	1	1	1	1	...	...	...	...	....
South Canisteo	1,480	20	122	Sept. 21	6	3	4	4	2	0	1	...	...	...	....
WYOMING															
Arcade	1,770	11	125	Sept. 26	3	0	3	2	1	0	1	0	0	1	....

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262 Apple orchard survey of Niagara county
265 On certain seed-infesting chalcis-flies
266 The black rot of the grape and its control
272 Fire blight of pears, apples, quinces, etc.
273 The effect of fertilizers applied to timothy on the corn crop following it
282 Seven methods of feeding young chickens
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285 The cause of "apoplexy" in winter-fed lambs
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289 Lime-sulfur as a summer spray
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314 Cooperative tests of corn varieties

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3 Some essentials in cheese-making
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6 Suggestions concerning treatment of seed corn with deterrents against crows
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SEPTEMBER, 1912 BULLETIN 317

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Farm Practice and Farm Crops

FURTHER EXPERIMENTS ON THE ECONOMIC VALUE OF ROOT CROPS FOR NEW YORK

Half-sugar mangels. The most desirable kind to grow for stock feeding

By EDWARD R. MINNS

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

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FURTHER EXPERIMENTS ON THE ECONOMIC VALUE OF ROOT CROPS FOR NEW YORK

EDWARD R. MINNS

The growing of root crops as feed for live stock can never become so important in New York State as the production of corn for silage. The value of mangels, carrots, and rutabagas as succulent food is generally acknowledged, but it is their comparatively high cost of production that will always limit the culture and use of even the best varieties.

In 1904 the Cornell University Agricultural Experiment Station began a study of cultural methods and varieties of root crops. For three consecutive years field experiments were made with numerous varieties of mangels, sugar beets, carrots, rutabagas, turnips, parsnips, and kohl-rabi. Those experiments are reported in bulletins 243 and 244. The trials were made on small plats and there was no attempt to show a definite cost relation between the production of nutrients in root crops and the nutrients in corn silage. Two objects of the experiments, as stated in Bulletin 243, were as follows:

(1) To determine whether root crops may be economically raised as a substitute for western grains, especially in the more northerly parts and higher altitudes of the State;

(2) To determine the best cultural methods.

A summary of the results states: " No doubt, in general, the greatest economy will be practiced by growing cabbages, rutabagas, and mangels for succession harvesting and feeding, more especially on farms where sheep and swine are kept." Judged on a dry-matter basis, it was found that sugar beets gave the highest average yield of dry matter. Mangels, half-sugar mangels, and rutabagas followed in order. One of the lessons deduced was: " A greater average yield of dry matter per acre may be obtained from mangels, half-sugar mangels, sugar beets, and rutabagas than from an average yield of corn. While it costs somewhat more per pound to produce this dry matter, yet it is quite probable that the higher digestibility and palatability of roots offsets this lesser cost of corn." Our recent experiments do not confirm this statement.

The fertilizer requirements of mangels were studied for two consecutive years on the Dunkirk clay loam soil of the Cornell University farms. The experiments were made during 1907 and 1908 and the results published in Bulletin 267, together with those obtained by tests of cultural methods for mangels and rutabagas in 1907. In these experiments acid phosphate and nitrate of soda were found to be the most profitable fertilizers on this particular soil. Lime applied for mangels was not profitable. Different results might be obtained on other types of soil. The garden drill was more efficient for seeding than the grain drill, and commercial seed was as good as home-grown seed.

For two winter seasons, beginning in 1907, experiments were made by the Department of Animal Husbandry at Cornell University in order " to determine the value of the dry matter in mangels as compared with the dry matter in silage, and to determine the value of the dry matter in mangels as compared with the dry matter in grain, in rations for milk-producing cows." The results of those experiments were published in Bulletin 268. The conclusions reached were in part as follows:

" One pound of dry matter in mangels is a little more than equal to one pound of dry matter in silage.

" One pound of dry matter in mangels is equal to one pound of dry matter in grain, and mangels may replace one half the ordinary grain ration with mixed hay and silage."

It was shown further that when mangels could be produced at $4 a ton they might be economically used to replace one half the grain rations ordinarily fed if commercial feeding-stuffs averaged $30 a ton.

RECENT EXPERIMENTS

The present bulletin reports the results of further practical experiments in the production of mangels and of silage corn during the four years 1908 to 1911, inclusive. The results of the previous experiments were used as guides in choosing varieties, in applying fertilizers, and in cultural methods. The crops of mangels and corn were grown on different fields of the Cornell University farms in the course of a definite rotation, but not always with the same previous preparation. The areas devoted to root crops were as large as the farm requirements for roots necessitated. For three years carrots and rutabagas were grown in the field with mangels and the results measured by the same methods. The areas devoted to corn were similar in size, and for three years occupied the same field with the mangels on as nearly uniform soil conditions as were possible in practice. The corn crop of 1911 was grown on the same soil type as was the mangel crop, but a farm roadway separated the two plats and their treatment the previous year was different, though conducive to good crops of each. The general plan of the experiments for four years was to grow the best possible crops of corn and roots by using as a guide the facts gained in previous experiments and the best-known practice for corn-growing on clay loam soils. The costs of seed, labor, and fertilizers for each kind of crop were kept, the areas measured, the yields weighed, and samples for analysis were taken by the Department of Farm Practice. Dry-matter and feeding-stuff analyses were made by the Department of Agricultural Chemistry.

The objects of these experiments may be stated thus:

1. To determine the comparative cost in seed, labor, and fertilizers of the best root crops and of silage corn grown on the university farms.

2. To determine the comparative cost of dry matter produced by root crops and by silage corn under practical conditions.

3. To compare the composition and total production of nutrients in root crops and in silage corn varieties.

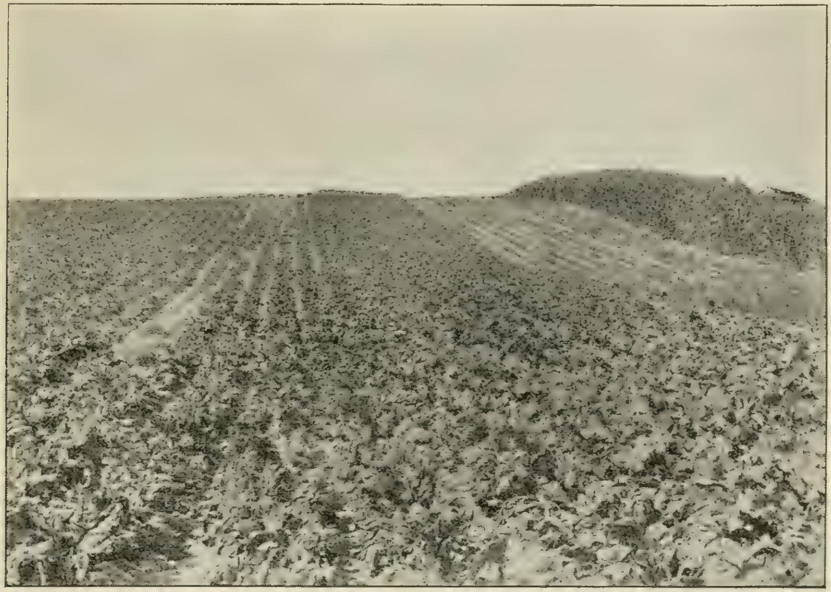

Fig. 152.—*Root crops and corn on a sandy knoll in 1908. Corn and rutabagas were very good, mangels were not a full stand, and carrots were nearly a failure. All had an equal chance*

The results obtained with carrots and rutabagas are not included in the tabulated data of this bulletin for the following reasons:

1. In two years out of three, the carrots showed greater sensitiveness to soil conditions than did the mangels. The cost of production was very high, and the dry-matter content of the carrots was lower than that of the mangels. By very careful preparation and culture a fairly good crop of carrots was secured the third year, but was not harvested because of very inclement autumn weather.

2. The rutabagas were a great success in 1908, owing partly to weather conditions. The production of dry matter was greater and the cost per

pound less that year than for the mangels. In 1909 a drought in midsummer, accompanied by an attack of plant lice, made the crop almost a failure and the cost of dry matter was very high. A moderately good crop was secured in 1910, but the mangels produced superior feed at less cost of dry matter. Because of their sensitiveness to weather conditions, the amount of soil necessarily harvested with them, and their limitations in feeding to cows, no further experiments with rutabagas were made.

The selection of mangel varieties for these experiments was made on the basis of yields of dry matter in previous tests, and ease of obtaining seed of these varieties from commercial seed houses. Two strains of the Long Red, called " Norbiton Giant " and " Chirk Castle," were used during the first two years. Both gave good yields of roots which were rich in dry matter; but because the seeds of the latter were much more expensive than those of the former, only the Norbiton Giant strain of Long Red mangel was used during the last two years of the experiments. A good half-sugar variety of mangel was grown each year; in yields and composition there was little to choose between this variety and the Long Red. The average yield and percentage of dry matter produced by these varieties for three successive years was as follows:

	Tons per acre	Percentage of dry matter
Half-sugar mangel	17.93	13.27
Long Red mangel	17.75	13.31

It was found that the half-sugar mangels pulled more easily at harvest time and carried less soil into storage than did the Long Red mangels. Careful determinations in 1908, when conditions were most favorable for harvesting mangels, showed that 5 per cent of the weight of Long Red mangels, as delivered at the root cellars, was soil. Of the half-sugar mangels 3 per cent of the weight was soil. In making comparative reports of the yields each year, the above figures were used to obtain the net weight of mangels produced.

The most dependable variety of corn grown for silage on the university farms is a yellow dent variety known as " Pride of the North." Other varieties that produce a greater yield of dry matter were tried once or more during the four years of experimenting. Some of these varieties were too immature at harvest, or else could not mature seed with certainty at Ithaca, and for practical reasons will hardly displace Pride of the North on the university farms. In 1908 the seed used was not home-grown and the date of planting was late. Although some ears were ripening at harvest time, the bulk of the crop was less mature than is most desirable for silage. Home-grown seed was used in the other three years. The strain as locally grown is a mixture of types and tends toward seed production. Eight quarts or more of seed corn are usually sown on an acre and the growth of well-developed ears is thereby discouraged. In 1910 the crop was allowed to mature too far for good silage while waiting for the other plats and fields to become ready for silage. It was mixed with less mature varieties in the silo. In 1911 the weights and samples of corn were taken five days after a killing frost that came unexpectedly on September 14.

Comparison of corn and mangels as to yields and cost of production

The comparative study that is here presented deals chiefly with the best variety of mangels used and the most dependable variety of corn available for four consecutive years. In Table 1 allowance is made for the comparison of yields and cost of the two crops for each of the four years. Considerable variation in yields and costs is shown, especially in the corn crop. Climatic conditions are largely responsible for the variable yields of corn fodder. The absence of any charge for barnyard manure is mainly responsible for the lower acre-cost of both crops in 1908. That year the climate and soil conditions favored the corn crop more than the mangel crop; in 1911 the climate and soil conditions seemed to favor the mangel crop more than the corn. The writer believes that the four-years averages are fair to both crops.

TABLE 1. Yields, and Cost of Labor, Seed, and Fertilizers, for Four Crops of Corn and of Mangels

	Year	Tons per acre	Cost per acre	Cost per ton	Cost per hundred pounds of dry matter
Pride of the North corn....	1908	20.35	$28 04	$1 38	$0 32
	1909	6.90	47 63	6 90	1 27
	1910	7.23	41 90	5 79	0 89
	1911	8.73	45 51	5 21	0 80
Mean...............	......	10.80	$40 77	$3 77	$0 71
Half-sugar mangels.......	1908	16.93	$66 36	$3 92	$1 48
	1909	17.30	87 24	5 04	1 75
	1910	20.00	76 88	3 84	1 58
	1911	26.35	78 65	2 98	1 37
Mean...............	......	20.14	$77 28	$3 84	$1 54

This table shows a mean yield of mangels nearly twice as great as that of corn fodder. No account is taken of the food value in the mangel leaves. The cost of a unit of dry matter in mangels is more than twice as great as that in corn. The cost of digestible dry matter in these crops is not shown because only average figures are available for such calculations. Assuming that dry matter in mangels is of more food value than is dry matter in silage corn, there is yet a wide margin between the cost of digestible nutrients in these crops.

Relation of weather to production of dry matter

How far the weather influences the production of corn and mangels may be seen from Table 2, in which is shown the relation of rainfall and temperature during the growing season to dry-matter production. The production of dry matter in corn crops seems to conform closely to the variations in temperature and rainfall that occurred during the five months of the corn-growing season. Mangels were less dependent on rainfall and temperature than on soil conditions for the production of dry matter. This fact makes the latter more certain as a crop in the variable climate at Ithaca.

TABLE 2. TEMPERATURE AND RAINFALL COMPARED WITH DRY MATTER PRODUCED BY CORN AND BY MANGELS FOR FOUR YEARS

	May 1 to September 30				
	Normal	1908	1909	1910	1911
Mean daily temperature (degrees F.)	64.5	66.3	63.7	63.9	66.5
Total precipitation (inches)	17.13	15.40	12.27	13.99	15.29
Dry matter, pounds per acre (*Corn*)	......	8,661	3,743	4,701	5,718
	May 1 to October 31				
Mean daily temperature (degrees F.)	62.0	64.0	60.8	61.9	63.7
Total precipitation (inches)	20.30	17.07	14.51	16.28	18.53
Dry matter, pounds per acre (*Mangels*)	......	4,486	4,976	4,876	5,755

Comparative composition of corn and mangels

The composition of corn fodder and of mangels, as shown in Table 3, accounts for the acknowledged difference in digestibility of the dry matter contained in these two crops. The lower percentage of crude fiber in mangels as compared with corn fodder cannot be offset by their greater moisture content, as is almost true of the protein and carbohydrates.

TABLE 3. ANALYSES OF CORN AND OF MANGELS FOR FOUR YEARS
(Percentages)

	Year	Moisture	Crude protein	Crude fat	Carbohydrates	Crude fiber	Ash
Pride of the North corn...	1908	78.72	2.26	.58	13.03	3.83	1.58
	1909	72.88	2.48	.85	16.96	5.40	1.43
	1910	67.49	3.06	1.13	21.75	5.25	1.32
	1911	67.25	3.39	.94	21.98	5.17	1.27
Average............	.....	71.58	2.80	.88	18.43	4.91	1.40
Half-sugar mangels......	1908	86.75	1.60	.04	9.86	.77	.98
	1909	85.62	1.69	.04	10.86	.74	1.05
	1910	87.81	1.60	.06	8.87	.76	.90
	1911	89.08	1.26	.06	7.90	.73	.97
Average............	.....	87.31	1.54	.05	9.37	.75	.98

Comparative acre production of nutrients

The above table shows that both the corn and the mangels used in these experiments were richer in nutrients than are those commonly grown for such purposes. The superiority of the mangels is due partly to the selection of varieties. The high food value of the corn is due partly to its degree of maturity and partly to the acclimated variety used. A truer index of the production of nutrients by corn and by mangels is found by calculating the weight of the total nutrients, and of each kind separately, produced on an acre of land. The results are shown in the following table:

TABLE 4. ACRE PRODUCTION OF NUTRIENTS FROM CORN AND MANGELS FOR FOUR YEARS
(Pounds)

	Year	Dry matter	Crude protein	Crude fat	Carbohydrates	Crude fiber	Ash
Pride of the North corn..............	1908	8,661.0	919.8	236.1	5,303.2	1,558.8	643.1
	1909	3,742.5	342.5	117.3	2,340.5	745.2	197.3
	1910	4,701.0	442.5	163.4	3,145.0	759.2	190.9
	1911	5,718.1	591.9	164.1	3,837.7	902.7	221.7
Average........	.....	5,705.6	574.1	170.2	3,656.6	991.5	313.2
Half-sugar mangels...	1908	4,486.4	541.8	13.5	3,338.6	260.7	331.8
	1909	4,975.5	584.7	13.9	3,757.6	256.0	363.3
	1910	4,876.0	640.0	24.0	3,548.0	304.0	360.0
	1911	5,754.8	664.0	31.6	4,163.3	384.7	511.2
Average........	.....	5,023.2	607.6	20.7	3,701.9	301.4	391.6

From these figures it appears that the mangel crops produced a higher average yield of crude protein, carbohydrates, and ash. The corn crops produced a much higher yield of crude fat and crude fiber. For the production of valuable nutrients on a given area of land, mangels were fully equal to corn in these experiments. The farmer who grows a small area of mangels in order to have succulent food for domestic animals during the winter months can produce as much food from an acre in mangels as from an acre in corn. Small silos and small areas in silage corn are relatively more expensive than larger ones. It will always be good economy for some farmers to grow small areas of root crops rather than to make silage of corn fodder for their uses. The last census reports (1910) show that in New York State 710 farms grew 663 acres of root forage, producing 6,670 tons. This was at the rate of less than one acre of roots on a farm and slightly more than 10 tons for each acre. The valuation per ton given by the census report was $8.10, but it must be remembered that part of the root forage thus reported probably consisted of carrots. These have a higher and more definite market value than do mangels.

COOPERATIVE EXPERIMENTS

In 1908 and 1909.— During the first two years of the experiments reported above, the writer directed some cooperative experiments with farmers in various parts of the State. The objects were to compare the yields of three varieties of mangels in each experiment, and to obtain some data as to the cost of fertilizers and labor in growing mangels in a small way on farms. Seeds of the three varieties used were furnished by the Department of Farm Practice at Cornell University and no charge was made for seed in the cost accounting. Eight of the experimenters reported results that could be used for comparison. In some cases the cost figures were hardly better than a shrewd estimate, but they serve the purpose of comparison very well. The results obtained are shown in Table 5:

TABLE 5. YIELDS AND COST OF PRODUCTION OF MANGELS GROWN BY COOPERATIVE EXPERIMENTERS IN 1908 AND 1909

Experimenter.	Tons per acre (average of three varieties)	Cost per acre	Cost per ton
H. L. Howe	22.11	$50 00	$2 26
George Helm	14.61	23 85	1 63
H. E. Walter	11.63	25 60	2 20
T. Mead Forbes	7.73	18 00	2 33
C. N. Crouch	3.33	20 08	6 03
A. W. Kusneske	10.88	36 23	3 33
H. S. Kimball	12.53	25 20	2 01
Arno Heck	10.43	40 50	3 88
Mean	11.66	$29 93	$2 96

It is noticeable that the best yield reported was obtained at the highest cost per acre, but not at the highest cost per ton. A fairly good yield at a moderate cost made a low cost per ton in one of the experiments. The average yield for the eight trials was not much higher than the average yield of root forage reported in the census. The average cost of a ton of mangels, after allowing an additional $5 for land rent and $4 for seed to sow an acre, seems to be within the cost limit set in Bulletin 268 for the economical production of roots to be used as a substitute for half of the grain ration in feeding dairy cows.

In 1910 further cooperative experiments were tried with a small number of farmers. One variety of mangels, the Long Red, was used. With it were grown a plat of corn for silage, a plat of soy beans and corn, and a plat of sunflowers and corn. The varieties of corn used were not prescribed and different varieties were chosen. The cost of labor and fertilizers was kept for both mangels and corn. Four experimenters reported results of a character allowing of comparisons. Their results are shown in Table 6:

TABLE 6. Cooperative Experiments in 1910 with Corn and Mangels

Experimenter	Tons per acre	Cost per acre	Cost per ton
Corn			
W. E. Hine	10.79	$11 50	$1 07
Roy S. Spencer	13.85	15 72	1 13
D. P. Witter	16.08	18 00	1 12
Towne & Fuller	10.53	7 60	0 72
Mean	12.81	$13 20	$1 01
Mangels			
W. E. Hine	13.23	$26 50	$2 00
Roy S. Spencer	10.25	32 14	3 14
D. P. Witter	21.00	26 40	1 26
Towne & Fuller	13.37	20 55	1 54
Mean	14.46	$26 40	$1 99

The cost of corn production was very moderate for eastern conditions. The yields were normal and creditable. The best crop of mangels was grown at the mean cost per acre for all four trials. The significant result was that, while the mangels yielded more tons per acre than did the corn, and the cost per ton was one third less than in the other cooperative experiments, yet the acre cost and the ton cost of corn-growing was practically one half that of mangel production. The number of experiments was not large enough to make the results conclusive, but since none of them show any extreme tendencies they may be considered fairly accurate. Results obtained during a series of years are more reliable than those obtained by several persons in the same year, because the yields of corn are subject to climatic conditions.

COMPARATIVE COST OF CORN AND MANGELS

At the Cornell station.—Why mangels cost more for each acre or for each ton than corn fodder can best be understood by studying the cost items of crops of corn and of mangels grown on the Cornell University farms during 1910 and 1911. The items for the 1910 crops were as follows:

COMPARATIVE COST PER ACRE OF CORN AND MANGELS, 1910

	Corn	Mangels
Autumn plowing	....	$4 18
Spring plowing	$2 81	2 81
Manuring, 1909 (one quarter cost)	8 64	8 64
Manuring, 1910 (one half cost)	14 26	....
Fertilizers	....	6 19
Fitting and planting	3 26	4 87
Seed	0 62	3 90
Cultivation	4 32	26 25
Harvesting	7 99	20 04
Total	$41 90	$76 88

The deep autumn plowing was thought to secure the best possible seed bed for mangels. The field had produced corn in 1909 after having received a heavy application of stable manure. The residual effects of manure on this soil were recognized by charging one half the cost of manuring to the crop for which it was applied, and one fourth the cost of manuring to the second crop following its application. Good practice requires the use of fresh manure for each crop of corn on this soil and the use of commercial fertilizers for root crops on previously manured fields. The cost of fitting the seed bed for mangels is greater than that for corn because the surface must be fined and leveled with a Meeker harrow in order to make the use of the garden drill possible. The cost of mangel seed is several times that of corn for the same area. The difference in cost of cultivating and harvesting the two crops is mainly responsible for the great difference in their economy. Corn is cultivated and harvested for the silo mainly by horse power; mangels are cultivated and harvested very largely by hand where the best yields are grown.

Somewhat different conditions prevailed in growing the two crops in 1911. An old meadow was well manured and broken for the corn crop. An adjoining plat, which had grown corn the year previous, was plowed only in spring for mangels. Plowing for corn was more expensive because more difficult. The relation between cost of seed, cultivation, and harvesting for the two crops was similar to that found in 1910. The cost per acre was higher in both crops, but the cost per ton was less because of better yields. The items of cost recorded for both crops for 1911 are shown below:

COMPARATIVE COST PER ACRE OF CORN AND MANGELS, 1911

	Corn	Mangels
Manuring (one half cost)	$14 96	....
Spring plowing	2 68	$2 39
Fertilizers	....	7 06
Fitting and planting	4 36	6 27
Seed	0 45	4 36
Cultivation	13 66	36 05
Harvesting	9 40	22 52
Total	$45 51	$78 65

At other stations.— A number of experiment stations report the cost of growing mangels, but the expense items charged are not uniform in all cases. More than twenty years ago Professor I. P. Roberts, who was then Director of the Cornell University Agricultural Experiment Station, reported the seed and labor cost of a very good crop of mangels grown on manured clover sod. The yield of dry matter in that crop was not reported. From the stations in Pennsylvania, Michigan, and Indiana, reports of mangel crops are available showing cost of production, yield of roots, and yield of dry matter in the roots. The Minnesota Agricultural Experiment Station reports the acre cost and the yield of mangels and silage corn, but says nothing about the dry matter produced in these crops. In order to compare these previous reports with the results given in the present bulletin, the following table has been made:

TABLE 7. EXPERIMENT STATION RESULTS WITH MANGELS AND CORN

Experiment station	Publication	Expense items charged	Mangel varieties	Year	Cost per acre	Tons per acre	Cost per ton	Dry matter, pounds per acre	Cost per hundred pounds of dry matter
Cornell.........	Bulletin 15...	Seed and labor..	Not named...........	1889	$83 87	35.88	$2 33	......	....
Pennsylvania...	Report 1893.. Report 1899..	Seed, labor, and fertilizer......	Long Red............ Long Red............	1892 1894	56 07 57 54	8.09 19.14	6 93 3 01	2,382 4,554	$2 35 1 26
Michigan.......	Bulletin 149..	Labor only.....	Long Red............ Golden Tankard.......	1897 1897	28 55 28 55	12.81 10.87	2 23 2 63	3,382 2,111	0 84 1 35
Indiana.........	Bulletin 77...	Labor only.....	Long Red............ Giant Yellow Intermediate Average 4 varieties....	1898 1898 1898	21 28 21 28 21 28	16.50 25.25 20.75	1 29 0 84 1 03	2,567 3,278 3,158	0 83 0 65 0 67
Minnesota......	Institute Annual No. 20	All expenses....	Not named...........	1906	32 79	32.50	1 01	......	....
Cornell.........	This bulletin..	Seed, labor, and fertilizer.	Half-sugar...........	1908–1911 av.	77 28	20.14	3 84	5,023	1 54
			Corn varieties						
Pennsylvania...	Report 1893.. Report 1899..	Seed, labor, and fertilizer......	Leaming............. Leaming.............	1892 1894	21 12 16 17	6.32 7 81	3 34 2 07	5,243 6,868	0 40 0 24
Minnesota......	Institute Annual No. 20	All expenses....	Not named...........	1905–1906	18 30	10.09	1 81	......	....
Cornell.........	This bulletin..	Seed, labor, and fertilizer.	Pride of the North.....	1908–1911 av.	40 77	10.80	3 77	5,706	0 71

THE CULTURE OF ROOT CROPS

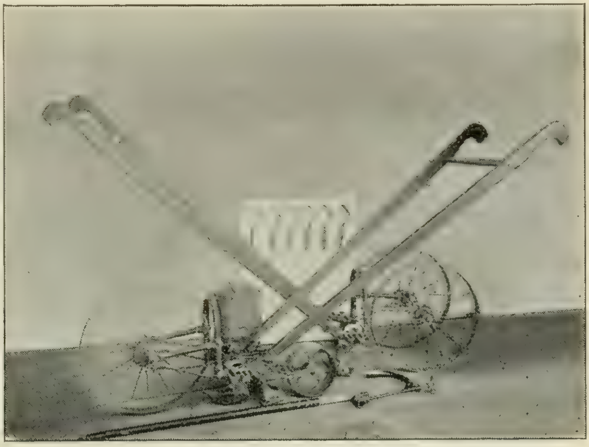

Fig. 153.—*Some useful tools for the culture of root crops*

There are many farms where a few bushels or tons of roots should be grown every year. Silage is not a safe feed for all farm animals under all circumstances. Some kinds of roots are to be preferred for horses, sheep, and poultry. Breeders of pure-bred cattle who are making advanced registry tests can make good use of such roots. Where labor is abundant and concentrated feed high, mangels, and possibly carrots, should be grown, to replace part of the grain ration for milch cows. If it is impracticable to have a silo on the dairy farm, then roots are needed as a succulent feed. In the higher altitudes and the northern counties of the State, root crops will thrive where corn growing may be impracticable. For those farmers who desire to cultivate root crops, the following suggestions are offered:

MANGELS

The soil.— Mangels should be rotated with other farm crops in order to avoid serious attacks of fungous diseases on their leaves. This vegetable will grow on a variety of soils. A clay loam, silt loam, or sandy loam is to be preferred to a gravelly soil because of the way in which small stones interfere with early cultivation. A soil which is deep and mellow without being very porous, and which is free from trash, might be considered ideal for the purpose. In general, soils that are adapted to corn growing can be made to produce mangels, although a finer seed bed is needed for mangels than for corn. Deep autumn plowing followed by somewhat shallower spring plowing should be practiced on soils of a tenacious character; a mellower seed bed results from this kind of preparation.

Fertilizing.— Fresh stable manure, if used, should be applied to the land during the previous season. Decayed manure may be applied before the spring plowing, with good results; fresh manure applied just before spring plowing is likely to make the roots less smooth and has been known to decrease the yield. Applications of lime have proved beneficial when the soil is rather deficient in lime. Commercial fertilizers, applied broadcast and harrowed in before seeding, are likely to produce paying yields if the proportions of available nitrogen, phosphorus, and potash in them are adapted to the needs of the soil on which the crop is grown. If the fertilizer can be mixed at home, a mixture of 150 pounds nitrate of soda, 300 pounds acid phosphate, and 50 pounds muriate of potash, applied to one acre while fitting the seed bed, should produce good results on most soils. On muck or peaty soils, more potash and less nitrogen would be better adapted. On very sandy soils a larger amount of potash should be used.

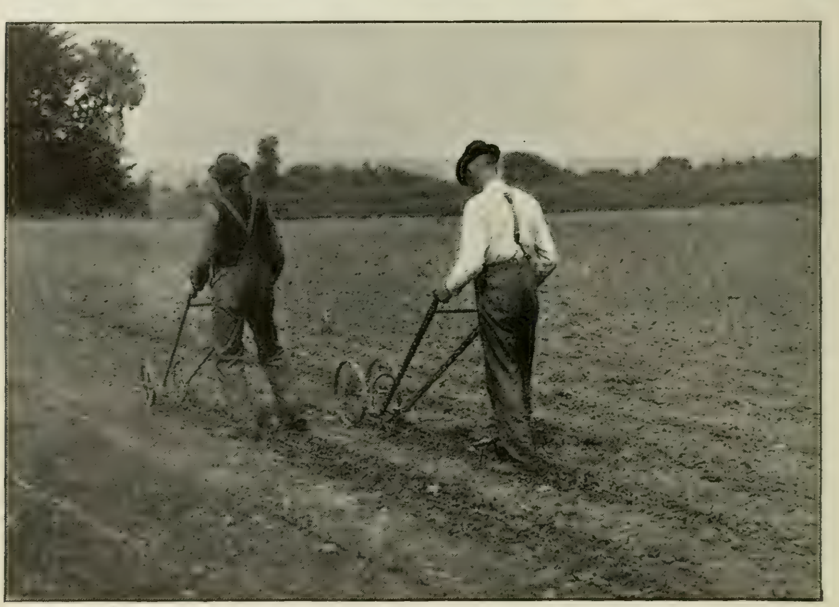

FIG. 154.—*The first cultivation should be with wheel hoes, working both sides of the row*

Available nitrogen is very important to the young mangel plants. Should parts of a field appear to be backward in growth after the plants are thinned, top-dressings of nitrate of soda at the rate of 100 pounds or more an acre may be broadcasted once every ten days on such places, when the leaves are dry, until the mangel foliage shows a normal vigorous growth.

Planting.— Mangels may be planted fairly early in spring. The surface of the mangel field should be smooth, as free from trash as possible, and fine enough so that the covering of the seed may be uniform. A garden drill is an excellent machine for sowing mangel seeds because the seeds are covered at a fairly uniform depth and the ground is firmed over the row by the rear wheel. The marker should be long enough to mark 28-inch or 30-inch rows. A special sugar-beet drill, or even a grain drill, may be used. The latter will sow three rows at once, but it does not firm the soil over the rows and the stand of plants may be imperfect. Mangel seed as sold by reliable seedsmen can be expected to germinate fairly well. It can easily be tested a few days before planting if economy in seed planting is necessary.

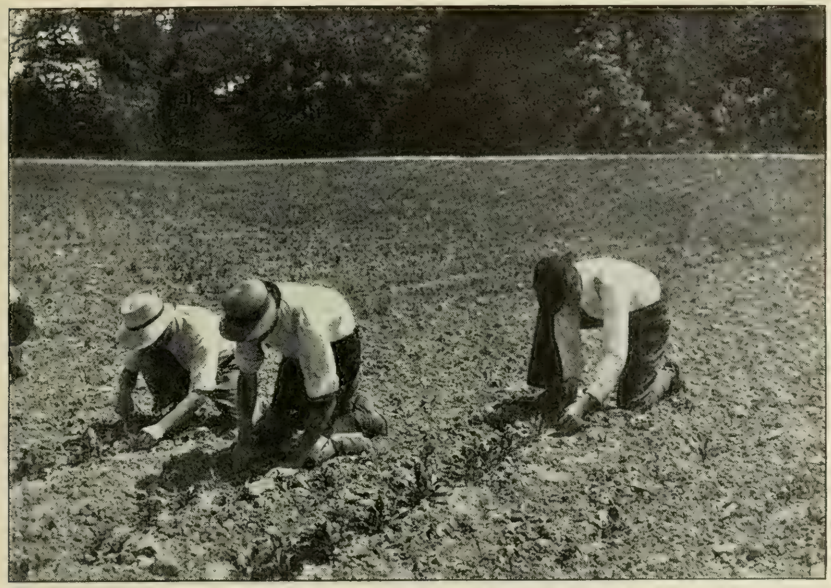

FIG. 155.—*The hardest part of root culture is weeding and thinning. Knee pads and hand weeders make the work less irksome*

Seedsmen sometimes recommend sowing 6 to 8 pounds to an acre. With the best of seed and ideal soil conditions, a stand of plants can be obtained with this amount of seed; but generally it will be best to use 10 or 12 pounds of seed and then leave the strongest plants when thinning. A garden drill may be set to drop the seed in hills a few inches apart, and in tenacious soils it is an advantage to have several plants breaking through the soil at one point if there is a crust on the surface.

In clay loam soils, three fourths of an inch is deep enough to plant mangel seed. In porous, or light soils, one inch or over may be the depth required to furnish the necessary moisture for sprouting the seed.

The aim should be to bury the seed where there is sufficient moisture, without covering it too deep for the seedlings to break through the soil crust after sprouting.

Cultivation.— The first cultivation of mangels is best given with wheel hoes astride the rows. If the rows are straight, the hoes may be set so close together that a very narrow row is left unhoed between them. This will kill most of the weeds that have sprouted as a result of firming the soil above the mangel seed. This cultivation should be given as soon as the rows of mangel seedlings can be plainly seen. If the weeds are not all killed close to the row the first time over, the hoe blades should be reversed and the wheel hoe driven once on each side of the row and as close to it as possible without injuring the mangels. This hoeing may be deeper than the first one and will loosen dirt and kill weeds well out to the middle of the row.

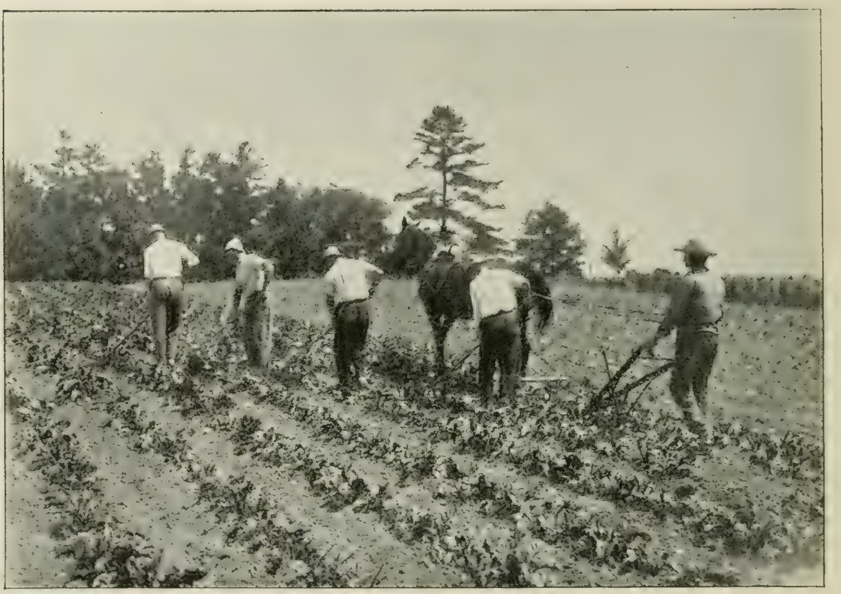

FIG. 156.—*Horse cultivation and hand hoeing follow thinning as soon as the mangels are large enough*

Weeding and thinning the mangel plants may be done first with a hand hoe, by cutting out of the row most of the plants not needed for a full stand. This process is called "bunching." Bunches of mangel plants are left standing in the row about 10 or 12 inches apart if the soil is fertile and a large variety is grown. This bunching should be done before the sixth leaf appears on the mangel seedling. The hardest task in connection with root culture comes after the bunching. The worker must stoop or kneel, and pull or cut out all but the best plant in each bunch. Hand weeders to assist the fingers and some kind of pads to protect the knees are useful in this task. Hand weeding and thinning should immediately follow bunching.

As soon as the surviving plants straighten, the horse cultivator should be used to loosen the soil tramped down in the thinning process and to kill the weeds left midway between the rows. The soil may be stirred several inches deep at first, but as the season advances the cultivations should be more shallow so as not to harm the roots of the growing plants, and should cease when the leaves touch one another across the rows. If weeds appear after the first weeding, hand hoeing or hand pulling may be resorted to. This task will be light if the first weeding has been thorough.

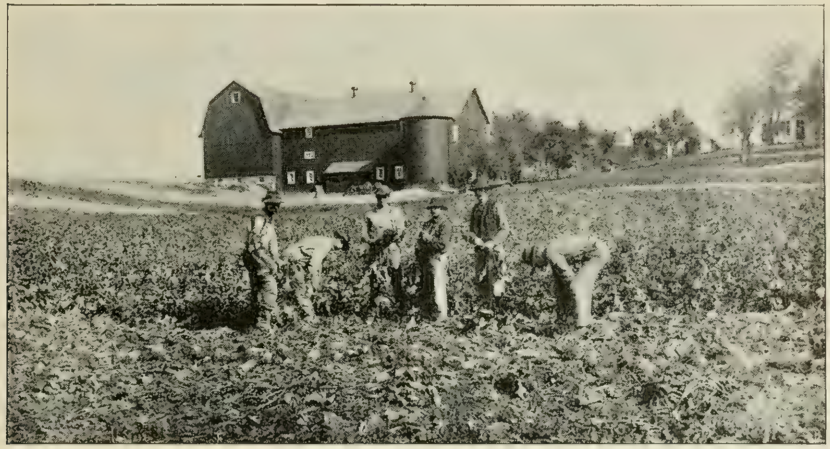

FIG. 157.—*Hand labor is needed for harvesting mangels. The tops are wrung off and left on the ground for manure*

Harvesting and storing.— Mangels should be harvested before wintry weather begins, but light frosts do not harm them. Late October or early November is the season when most root crops are harvested and stored.

Mangels grow mainly above ground and are pulled by hand. The tops should be wrung off, not cut. If the roots are large, crates or baskets will be of no advantage in handling them; an open wagon box is the handiest carrier for transporting them from the field. If stored in a root cellar or in a pit out of doors, ventilation should be given until severe weather sets in, for the roots sweat when first stored. The mangels should keep until the following summer if stored properly and not frozen before harvesting.

CARROTS

Carrot culture is more exacting than that required for mangels. The seeds are much smaller and are slower to germinate, and the seedlings are small and weak until after midsummer. The plants seem to make the largest part of their growth after the hot days of summer have passed. They are sensitive to the physical condition of the soil and need intensive, or garden, cultivation more than do mangels.

Preparation of soil.— The previous preparation of the soil should be the same as for mangels, except that less stones or trash can be tolerated at the surface of the field for carrots. As the seeds of carrots are slow to germinate and must be planted shallow, it will be found best to prepare the seed bed some time in advance of sowing, and allow it to settle and the weed seeds to sprout before the final fitting of the surface. When ready for planting, a carrot field should be very smooth, fine, and moist near the surface.

Seeding.— The amount of seed sown will depend on the quality of the seed and the width of the rows. The plants should stand 4 to 5 inches apart in the rows after thinning. If good seed is used, the drill should be so adjusted that not more than four seeds are sown for every plant desired; if the seed is of poor germinating quality, more accordingly should be sown. The seed should be covered about one fourth of an inch deep and the rows should not be trampled with the feet.

Some carrots are grown in rows wide enough to allow of horse cultivation; but larger crops can be obtained if the rows are not wider than 16 inches and the cultivation is all done by hand power. It is late in the season before carrot plants are large enough to cultivate safely with a horse. The garden drill for sowing, and the wheel hoe and hand cultivator, are most useful tools in carrot culture.

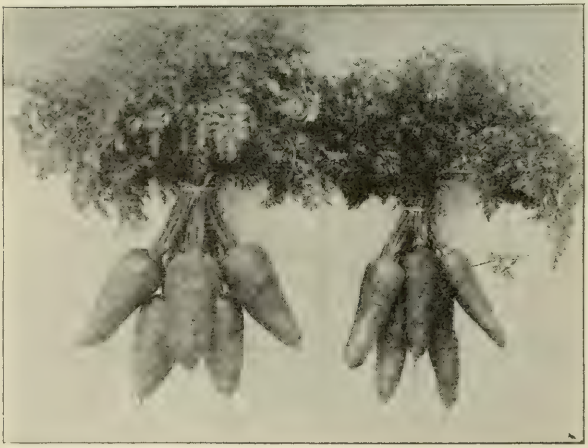

FIG. 158.—*Improved Rubicon and Danvers Half-long carrots. This type is fairly easy to harvest and is capable of good yields*

The large, long varieties may be grown for stock feeding, but there is no reason why half-long, or even stump-rooted, kinds may not yield fully as large crops if given the right culture. The difficulty of harvesting long carrots is an objection to their cultivation.

Care of the crop.— The labor of weeding and thinning carrots is more arduous than that needed for mangels. Little or none of it can be done with a hand hoe and yet leave the plants near enough together in the row. The labor of harvesting is proportionately greater for carrots, as not all the roots can be pulled without the aid of a fork or of the plow. The tops should be wrung off and the roots stored the same as mangels. In the field, baskets or crates can be used to advantage to handle the roots.

RUTABAGAS, OR SWEDES

These roots are more uncertain than mangels to grow, but they should not cost so much for previous preparation and for seed. The previous preparation of the soil need be no better than for corn unless an early crop of roots is desired. If rutabagas are sown as early as mangels are sown, or about May 1, the crop will be ready for harvest in September.

To grow a crop of swedes for winter feeding, sow the seeds from June 10 to 20, on land that has been plowed early and kept in good condition by occasional harrowing to kill weeds and to save moisture. If the rows are 30 inches wide, 2 pounds of good seed will be ample for an acre. Varieties that produce good-sized, smooth roots should be preferred to those with many fibrous roots. The seeds should be covered one fourth to one half inch deep. The surface conditions of the field will need to be as good as when mangels are sown.

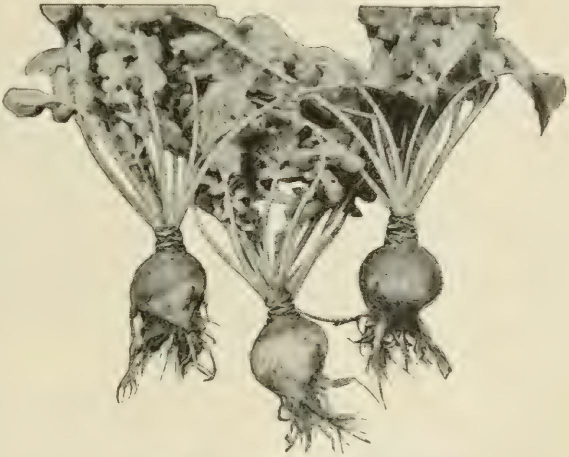

FIG. 159.—*Bloomsdale rutabagas; a desirable type. Varieties having less of the fibrous roots are seldom found*

Practically the same operations are required to hoe, thin, cultivate, and harvest swedes as are needed for mangels.

COMMON TURNIPS

White-fleshed turnips, when grown for stock feeding, are hardly worth the trouble to sow in rows and cultivate. If there is moisture enough to sprout the seed and keep the plants growing, they should be sown as a catch crop late in July after removing an early cultivated crop such as potatoes, or on land plowed late and freed from weeds by harrowing. They are sometimes sown in cornfields after the last cultivation, and a crop obtained. One pound of seed to an acre, sown broadcast on freshly cultivated soil, will be ample if moisture conditions are favorable. No thinning nor weeding should be required for such late-sown turnips. They may be harvested and stored the same as swedes.

SUMMARY

1. Previous studies with root crops at this experiment station have indicated what varieties may be successfully grown, their cultural requirements, the effects of fertilizers on mangels, and the value of mangels as a substitute for part of the grain ration fed to milch cows. This bulletin describes further studies in the economy of growing the best varieties of mangels in competition with corn for the silo.

2. Mangels proved to be a more reliable crop than did rutabagas or carrots, and were less influenced by climate than was corn.

3. The cost of producing mangels, both at the experiment station and in cooperative experiments with farmers in other localities, was low enough to allow of their profitable substitution for grain in rations for milch cows.

4. The cost of dry matter in mangel crops was more than twice as much as the cost of dry matter in corn crops on the university farms. In similar cooperative experiments, the cost in labor and fertilizers of a ton of mangels was nearly twice as great as the cost of a ton of corn fodder.

5. Brief directions are given for growing crops of mangels, carrots, rutabagas, and turnips.

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CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Poultry Husbandry

CONSTITUTIONAL VIGOR IN POULTRY

Under the direction of
JAMES E. RICE

By C. A. ROGERS

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

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CONTENTS

PAGE

Part I. The first year's work 573
  - Object 573
  - Selection and summer care of the chickens 573
  - Condition of pullets when put into winter quarters . . . 575
  - The kind and size of houses and yards 576
  - Winter care and feeding 577
  - General observations 578
  - Data
    - Food consumption 578
    - Broodiness and mortality 581
    - Molting 582
    - Egg production 582
    - Weight of eggs 584
    - Cost per dozen eggs produced 584
    - Incubation 586
    - Development of the chicks 587
    - Financial statement 588

Part II. The second year's work with the original fowls 590
  - Food consumption 590
  - Broodiness and mortality 592
  - Egg production 592
  - Weight of eggs 593
  - Cost per dozen eggs produced 594
  - Incubation 594
  - Chick mortality 596
  - Financial statement 597

Part III. The progeny from the original flocks 599
  - Food consumption 599
  - Broodiness and mortality 601
  - Egg production 601
  - Weight of eggs 603
  - Cost per dozen eggs produced 605
  - Incubation 605
  - Chick record 606
  - Financial statement 607

Part IV. The combined two years' work with the original flocks 608
  - Food consumption and egg production 608
  - Mortality 609
  - Incubation 610

Part V. A summary of all flocks 611
  - Food consumption and egg production 611
  - Mortality 613
  - Incubation 613
  - Conclusions 614

CONSTITUTIONAL VIGOR IN POULTRY*

C. A. Rogers

PART I

THE FIRST YEAR'S WORK

Considerable anxiety is being expressed regarding the large mortality among fowls, and especially among chicks. The recent losses have been sufficiently heavy to dampen the ardor of many previously successful poultry breeders and in not a few instances to financially embarrass or totally discourage others. The lack of a tangible cause to which this large mortality may be attributed intensifies the seriousness of the situation.

In order to learn whether constitutional vigor is a strong deciding factor in the control of this condition, the experiments herein reported were made. The results are among the first obtained from a series of experiments, observations, and comparisons on constitutional vigor in poultry at this experiment station.

A Reading-Course lesson (No. 45, March, 1909) on "Importance of Constitutional Vigor in the Breeding of Poultry" has preceded this bulletin. Its conclusions were based, in part, on the same findings.

OBJECT

The object of these experiments was to obtain data on the relative power of production and reproduction of pullets which, under the influence of quickly digestible and nourishing foods, were able to overcome an apparent weakness, in comparison with the power of those of their sisters which under the same management had at no time shown weakness. In addition to the practical information obtained on proportionate egg yields, food consumption, and mortality, there is special significance in the influence of such parentage on the fertility and hatching power of the eggs and on the constitutional vigor of the chicks hatched.

SELECTION AND SUMMER CARE OF THE CHICKENS

Experiment I

Early in the summer of 1907 a large colony of chicks showed at ten weeks of age such uneven growth and so much difference in health that separation into a strong and a weak flock was advisable. The stronger chickens were given ideal range conditions, with grass pasture and abundant space and shade. They were hopper-fed with whole grain, dry mash, grit, and oyster shell. Under these conditions the chicks continued their normal growth.

---

* Mr. W. S. Lyon had the general care of the flocks in the experiments discussed in this bulletin.

The grain mixture given consisted of 3 pounds cracked corn, 2 pounds wheat, and 2 pounds hulled oats. The dry mash mixture was made up of equal parts by weight of corn meal, wheat bran, wheat middlings, and bone meal, with 4 pounds meat scrap and 0.4 pound charcoal. The pullets consumed about eight to ten times as much of the whole grain as of the ground mixture.

The weaker chickens were placed in fattening houses with small yards, having little grass or green food available other than that brought to them. They were given a fattening ration of 100 pounds corn meal, 100 pounds oat meal, 100 pounds whole wheat middlings, and 42 pounds meat scrap, mixed rather soft with sour milk and fed morning and night. Under this care the weak chickens began at once to improve. They increased rapidly in weight and their feathers became sleek and smooth in contrast to their previously ruffled, unkempt condition. As they reached the broiler stage the cockerels were marketed, leaving only pullets. By this time many of the pullets had developed so satisfactorily that they would have been retained by most farmers for laying, or even for breeding purposes.

The best thirty White Leghorn pullets from the fattening pen were leg-banded and transferred to a range, with the same number of their stronger sisters; these also were leg-banded, to be used later for comparison. Both lots remained under these conditions until placed in the laying pens in the fall, at which time they were known as pens 78 (strong) and 79 (weak).

At the time of this selection (August 3, 1907) the weaker pullets averaged 0.75 pound in weight, while their stronger sisters averaged 1 pound.

Experiment II

The pullets for the second experiment were selected according to physical vigor, as in experiment I, from a fattening pen of White Leghorns on August 9, 1907. Only the strongest individuals of these one-time weak chicks were sorted out, leg-banded, placed under range conditions, and cared for in the same way as was the stock used for the first comparison. The stock for this experiment came from a hatch of chicks three weeks later than those used in experiment I. The stronger sisters to be used in comparison with these previously weak individuals were not selected until fall, when the stock was penned in winter quarters. They are pens 76 (strong) and 75 (weak).

Experiment III

For the purpose of comparing two different breeds of poultry as to their constitutional vigor, a number of Barred Plymouth Rock pullets were saved from the same hatch as was used in experiment II. These Barred Plymouth Rock pullets also had apparently overcome their earlier weakness. The selection, general care, and all conditions surrounding this third lot, to be known later as pens 21 (strong) and 23 (weak), were similar to those in experiment II with White Leghorns.

The stronger sisters to be used in comparison with these individuals were chosen from the same hatch. They were not selected, however, until the time of housing the flocks in their winter quarters.

It should be understood that in each lot the pullets chosen for the weak pens were, at the time of their selection, such as would ordinarily be considered strong and active individuals. They were termed the weak flocks because at one stage of their growth they had shown such weakness that, in order to save their lives, a specially digestible and nourishing ration had been given them. Many of the other pullets given this ration did not develop satisfactorily. It is evident, therefore, that the term "weak" as applied to these flocks needs to be interpreted in the light of the foregoing statements. All fowls used in the experiments were pullets that ordinarily would have been retained as healthy stock.

CONDITION OF PULLETS WHEN PUT INTO WINTER QUARTERS

Several months elapsed between the time of selecting and the time of housing these pullets. During that period many individual changes occurred. This was especially pronounced in experiment I. Here several of the previously weak pullets, failing to retain their temporary strength acquired under special feeding, again gave signs of low vitality; furthermore, several of their stronger sisters selected at the same early date failed to maintain their original vigor: so that the two flocks (78 and 79), when finally penned up for winter observations, showed to outer appearance but slight differences in degree of vigor except in the average weight of the pullets. The pullets in flock 78 (strong) averaged 3.5 pounds, while those in flock 79 (weak) averaged only 3.1 pounds.

The pullets selected for the weaker flocks in experiments II and III showed similar individual reverses. Consequently, both the White Leghorn and the Barred Plymouth Rock flocks of low vitality included, when the records of feeding and production actually began, some excellent, as well as some unquestionably weak, individuals.

The two stronger flocks to be compared with the low-vitality flocks of experiments II and III were assembled at this time from the choicest pullets of similar age and parentage. In these two pens of strong pullets there were consequently, at the start, no weak individuals, but only pullets that were strong and healthy.

The average weight of the low-vitality White Leghorn pullets in experiment II at this period was 3.56 pounds, while that of the high-vitality comparison flock was 3.74 pounds. The Barred Plymouth Rock pullets in the low-vitality flock (experiment III) averaged 3.9 pounds and their stronger sisters 5.2 pounds.

In order to interpret intelligently the tabulations that follow, it is necessary to bear in mind the exact conditions surrounding each flock chosen for these comparisons. Only one selection was made. If a fowl in the strong pens became weak or one in the weak pens gained in strength, it was neither removed nor transferred.

THE KIND AND SIZE OF HOUSES AND YARDS

The flocks to be directly compared were placed in houses identical in size, shape, equipment, and exposure, with yards of equal size and under similar cultivation. Each house was equipped with trap nests and the usual feed cans, hoppers, and water pans.

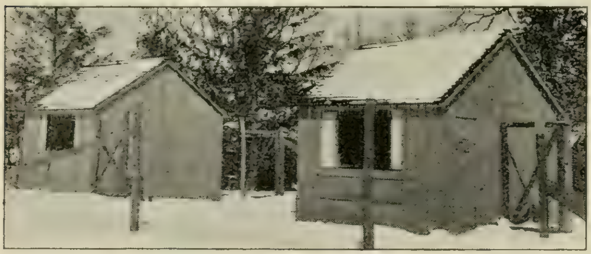

FIG. 160.—*The buildings in which flocks 78 and 79 were housed*

Flocks 78 and 79 were put in colony houses of the gable-roof type, shingled and tightly constructed (Fig. 160). These houses had board floors laid near the ground. There were no glass windows. One large cloth window, with its lower edge about 3 feet above the ground, served to admit light and provide ventilation. Each fowl was allowed 4.8 square feet floor space, 42 cubic feet air space, 0.6 square feet cloth-window opening, and 12.4 square feet yard area. In these small yards the soil soon became bare.

Flocks 76 and 75 were given colony houses of the shed-roof type, with paper-covered roofs (Fig. 161). The board floor in these pens was raised about 1 foot above the ground. These houses were also without glass windows, but a large adjustable cloth curtain provided abundant ventilation and allowed sufficient sunlight to enter. The opening covered by this curtain was about 3 feet above the floor. Each fowl was given 4 square feet floor space, 22.4 cubic feet air space, 1.36 square feet cloth-window surface, and 43.9 square feet yard area.

Flocks 21 and 23 were put in pens in the New York State fresh-air house, having concrete floor and both glass and cloth windows (Fig. 162). This house is of the shed-roof type, with paper-covered roof. Each fowl was given 5.8 square feet floor space, 39.4 cubic feet air space, 0.66 square feet cloth-window surface, 0.45 square feet glass-window surface, and 19.9 square feet yard area. A complete description of the house is given in Bulletin 274 of this station.

Fig. 161.—*The buildings in which flocks 76 and 75 were housed*

WINTER CARE AND FEEDING

All flocks received similar treatment, care, and food. Similar alterations in method of treatment or in care were made for each flock to be compared.

The grain ration was fed rather sparingly in a litter in the morning and more abundantly at night. At noon either beets, cabbage, or grass, as green food, or green cut bone, was thrown to the fowls in quantities varying with the number of fowls in the pen. At this time the dry mash hoppers were opened and left open until night. During the early summer months fresh-mown grass was thrown to the fowls. Grit, oyster shell, and fresh water were constantly before them.

The grain ration consisted of 2 pounds cracked corn, 2 pounds wheat, and 1 pound oats, having a nutritive ratio of 1 pound protein to 7.8 pounds carbohydrates and fat. During the period between December 31, 1907, and March 10, 1908, oats were omitted from the ration.

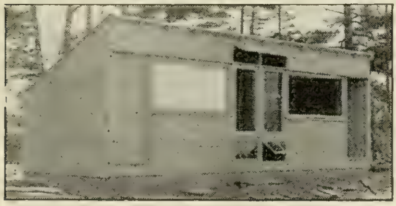

Fig. 162.—*The type of pens in which flocks 11 and 13, 12 and 14, 20 and 22, and 21 and 23 were housed*

The dry mash ration remained constant throughout the year, consisting of 6 pounds corn meal, 3 pounds wheat bran, 6 pounds wheat middlings, 1 pound alfalfa meal, 1 pound old process linseed oil meal, and 5 pounds meat scrap of 65 per cent protein. This mixture gives a nutritive ratio of 1 pound protein to 1.8 pound carbohydrates and fat. The grain and the mash were fed in the proportion of about four times as much grain as mash.

GENERAL OBSERVATIONS

Each flock had, when penned up, a total of twenty-five pullets. Two males were put in each pen. In pens 21, 76, and 78 (strong) and pens 23 and 79 (weak) strong males were used, while weak males were put in pen 75 (weak). This arrangement allows a comparison between flocks containing strong females with strong males, weak females with weak males, and weak females with strong males.

In view of the difficulty of keeping White Leghorns within fences, especially when confined in small yards, the pullets in the separate flocks were marked with a distinctive color,* either on a wing or, preferably, on the tail. This enabled the attendant to discover quickly any mixing of the fowls. It was found that when fowls were thus distinctively colored they were more likely to remain in their own yards. Fowls seem to have an aversion on first acquaintance to individuals of a different color, and the discomfort to which a hen was subjected when straying into another yard usually taught her to remain at home.

The fowls were weighed individually at the end of every fourth week. Trap-nest records were kept of each pullet's production. All foods were weighed out and charged to the separate pens. Whenever a death occurred the date of death was recorded so as to obtain the exact number of " hen days " and make it possible to put food consumption, egg production, broodiness, and the like in " per hen " terms.

DATA

The following paragraphs contain an interpretation of the data obtained during the first year of feeding:

Food consumption

It would be natural to expect a constitutionally strong individual to eat and digest a greater amount of food than would a weaker one. The average consumption for a year of the three strong pens, as shown in Table 1, is 1.46 pound greater for each fowl than that of the weak pens. Further examination of this table, however, shows that the average fowl in pen 79 (weak) consumed more than the average in pen 78 (strong). This irregularity can be explained only by the manner in which the two lots were selected (page 574). The consumption of food in the strong and weak pens of both the fall-selected lots was consistent with that of the average strong and weak fowls of the three experiments. The total amount of grit and shell eaten varied in the different pens in the same way as the food consumed.

---

* The following is a list of the aniline dyes that have been tried at this station, named in the order of their efficiency:

- Auramine yellow
- Rhodamine red
- Safranine red
- Purple
- Blue
- Green
- Wine color
- Bismarck brown
- Indelible black (liquid)

The auramine yellow is the most durable and is not injurious to the eyes of the fowls.

Rhodamine red is somewhat like snuff and is a little more objectionable to handle than the others, although it seems to last better, perhaps, than safranine red.

Green lasts well, but is objectionable as it injures the eyes when the fowls rub their faces in the moist, newly colored feathers.

Indelible black is not durable, it is very aromatic, and its fumes are injurious.

To prepare the dye for use mix with wood alcohol, putting in just as much dye as the alcohol will absorb. This means approximately 1 tablespoonful of dye to 1 pint of wood alcohol, the amount of dye varying according to the color; some colors are much heavier and stronger than others and are also much harder to dissolve in the alcohol. The addition of other liquids, such as acetone, shellac, and castor oil, does not seem to improve the simple mixture of dye and alcohol.

The consumption of ground feed was, in most pens, about one fourth that of whole grain. This proportion varied much in relation to the egg production from the different pens. As the consumption of whole grain was practically the same for all flocks of the same variety of fowls, any variation in the amount of ground feed to whole grain consumed was due to the amount of ground feed eaten. The flock that ate the greatest amount of ground feed laid the largest number of eggs, and the flock that ate the least amount of ground feed laid the smallest number of eggs. (Tables 1 and 5.)

TABLE 1. Consumption of Food per Hen (in Pounds)
(December 10, 1907, to December 7, 1908)

	Summer selected		Fall selected				True average*		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	......	......	......	......
Total, including grit and shell	81.05	91.02	81.46	72.93	103.79	96.22	88.80	87.34	1.46	......
Total, not including grit and shell	76.65	85.60	78.21	70.52	98.73	92.38	84.55	83.33	1.22	......
Total whole grain	51.56	55.34	55.66	54.77	68.99	68.06	58.72	59.76	......	1.04
Total ground grain	14.76	18.31	11.75	7.22	16.30	13.59	14.30	13.19	1.11	......
Total whole and ground grain	66.32	73.65	67.41	61.99	85.29	81.65	73.02	72.95	0.07	......
Total grit and shell	4.40	5.42	3.25	2.41	5.06	3.84	4.25	4.01	0.24	......
Pounds of whole grain to each pound of ground grain	3.49	3.02	4.73	7.58	4.23	5.00	4.10	4.53	......	0.43
Percentage of meat scrap to grain	6.61	6.78	5.19	3.59	5.58	4.93	5.80	5.13	0.67	......
Pounds of other foods to each pound of grit and shell	17.42	15.76	24.06	29.26	19.51	24.05	19.89	20.78	......	0.89

* The "true average" in all tables is obtained by using the totals in the original data instead of the "per hen" data.

The proportion of meat scrap eaten depended on the amount of ground feed consumed. The proportion of this meat food to the other food was small, in no case aggregating so high as 7 per cent.

Similarly, the consumption of grit and oyster shell was proportionate to the consumption of other foods and to the production of eggs. The flock consuming the largest amount of ground feed and laying the largest number of eggs ate the greatest proportion of grit and oyster shell, and vice versa. In all cases the consumption of oyster shell was greater than that of grit.

The consumption of oyster shell varied according to the egg production. The number of pounds of eggs produced averaged very nearly the same for every pound of oyster shell consumed in each pen. The hens that laid the largest number of eggs ate the greatest amount of shell. The consumption of grit was in much the same ratio to the egg production, but varied in different pens more than did that of the oyster shell.

The ratio of protein to carbohydrates and fat was about the same for all pens. Whatever variation there was is due to the relative consumption of whole grain, as compared to that of ground feed with which meat scrap was mixed. (Table 2.)

TABLE 2. TOTAL FOOD NUTRIENTS (IN POUNDS)*

(December 10, 1907, to December 7, 1908)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	......	......	......	......
Dry matter	63.66	71.61	67.43	58.33	81.99	78.08	71.01	69.87	1.14	......
Ash (including grit and shell)	6.15	7.50	5.10	3.90	7.35	5.95	6.25	5.83	0.42	......
Protein	9.47	10.77	9.12	7.47	11.66	10.75	10.09	9.74	0.35	......
Carbohydrates	41.75	46.61	43.46	39.98	54.52	52.49	46.58	46.68	......	0.10
Fat	2.70	3.02	2.72	2.32	3.33	3.13	2.91	2.84	0.07	......
Ratio of protein to carbohydrates and fat	5.05	4.96	5.43	6.05	5.31	5.53	5.26	5.45	......	0.19

* The analyses used in computing the tables on " total food nutrients " are as follows:

Food	Dry matter	Protein	Carbohydrates	Fat	Ash
Corn	89.4	7.9	66.7	4.3	1.5
Wheat	89.5	10.2	69.2	1.7	1.8
Oats	89.0	9.2	47.3	4.2	3.0
Buckwheat	87.4	7.7	49.2	1.8	2.0
Corn meal	88.0	7.9	65.3	2.9	1.4
Wheat bran	88.1	12.2	39.2	2.7	5.8
Wheat middlings	87.9	12.8	53.0	3.4	3.3
Oil meal	90.8	29.3	32.7	7.0	5.7
Alfalfa meal	91.6	11.0	39.6	1.2	7.4
Meat scrap	88.3	66.2	0.3	13.7	4.1
Blood meal	91.5	84.4	0.0	2.5	4.7
Beets	9.1	1.1	5.4	0.1	1.1
Cabbage	15.3	1.8	8.2	0.4	1.4
Turnips	9.5	0.7	5.3	0.2	0.8
Green bone	65.8	18.0	43.0	0.0	11.5
Oyster shell	100.0	0.0	0.0	0.0	100.0
Grit	100.0	0.0	0.0	0.0	100.0
Sprouted oats	26.1	3.5	15.2	1.1	1.5

Although the amount of food consumed was on the average greater in the strong pens, Table 3 shows that in all instances the amount of dry matter required to produce each pound of eggs was less for the strong fowls and greater for the weak ones, showing a more economical use of the food by the strong fowls:

TABLE 3. THE PROPORTIONATE CONSUMPTION OF FOOD PER POUND LIVE WEIGHT AND PER POUND EGGS PRODUCED

(December 10, 1907, to December 7, 1908)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	....	......	....	......
Pounds dry matter consumed per pound live weight	17.20	20.40	17.75	16.43	13.55	15.05	15.71	16.34	....	0.63
Pounds dry matter required per pound eggs produced	3.92	4.32	4.45	4.97	5.00	5.24	4.44	4.77	....	0.33
Pounds of food required to produce 1 dozen eggs	7.49	8.24	8.07	9.44	9.50	9.69	8.33	8.95	....	0.62

In nearly every comparison the stronger fowls made a more economical use of their food, both in dry matter consumed per pound live weight and in dry matter required per pound of eggs produced. Although the Barred Plymouth Rocks consumed more total pounds of dry matter than the White Leghorns, they used less per pound live weight because of their greater size. The Plymouth Rocks, however, required a greater amount of dry matter to produce each pound of eggs laid.

Broodiness and mortality

There seemed to be a uniformity in broodiness among the White Leghorn fowls, both weak and strong. In no instance was the number of broody fowls unusual. The greatest broodiness occurred in the strong Barred Plymouth Rock pen 21, where, on the average, each hen was broody 3.3 times and lost 16.9 days thereby. (Table 4.) In both the strong and weak flocks the Plymouth Rocks were much more broody than the White Leghorns.

The greater number of deaths occurred among the weaker fowls. The large mortality in pen 75 (weak), as shown in Table 4, is due to a vicious habit of cannibalism which the fowls developed at the start. Five of this flock died as a result of injuries inflicted by the other fowls. This

TABLE 4. BROODINESS AND MORTALITY
(December 10, 1907, to December 7, 1908)

	Summer selected		Fall selected				Total		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	....	......	....	......
Number of hens broody	21	19	16	17	74	45	111	81	30	......
Days broody	105	109	55	82	373	213	533	404	129	......
Number died	0	4	2	7	3	2	5	13	....	8
Percentage mortality	0	16	8	28	12	8	....	......	....	......

cannibalism started when the pullets commenced laying, at which time the strain of producing the first eggs caused eversion. The three deaths in pen 21 (strong) are unaccountable, since the fowls were apparently healthy.

Molting

Both the weak and strong White Leghorn fowls progressed at about the same rate throughout the molting period, which extended from the latter part of July to the end of December. The average fowl, of course, required but a part of this time. The strong Barred Plymouth Rocks were about a month earlier in finishing their molt than the others. The weak Barred Plymouth Rocks were even slower than the Leghorns, and, in fact, several did not complete their molt in that they failed to renew the tail feathers and some of the head and neck feathers.

Egg production

The true average percentage of eggs yielded was uniformly higher in the strong than in the weak pens, except for the two periods September 15 to October 12 and October 13 to November 9, when the weak pens in all three comparisons gave a higher production. During the last period, November 10 to December 7, the strong pens again took the lead. (Table 5.)

The highest average production was during the months of March, April, May, and June, at which time it was 55.1 to 66.8 per cent average in the strong pens and 49.3 to 58.6 per cent average in the weak pens. During the other months it was considerably lower in all the flocks.

One reason for the weak pens producing more heavily during September and October is undoubtedly that the hens in the weak pens were molting somewhat more slowly and later than those in the strong pens.

TABLE 5. PERCENTAGE OF EGG PRODUCTION BY PERIODS
(December 10, 1907, to December 7, 1908)

Period	Date	Summer selected		Fall selected				True average percentage		Difference	
		White Leghorns		White Leghorns		Barred Plymouth Rocks					
		Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
		Pen 78	Pen 79	Pen 76	Pen 75	Pen 21	Pen 23	......	......	......	......
1	Dec. 10–Jan. 6....	19.1	13.7	16.5	11.4	3.0	0.1	12.9	8.5	4.4	......
2	Jan. 7–Feb. 3.....	35.4	37.4	29.9	19.9	27.7	1.5	31.5	22.6	8.9	......
3	Feb. 4–Mar. 2.....	28.5	35.3	16.6	20.7	39.2	22.3	28.2	26.0	2.2	......
4	Mar. 3–Mar. 30...	52.9	57.1	61.7	49.2	50.7	42.3	55.1	49.6	5.5	......
5	March 31–April 27.	62.9	65.0	73.0	50.6	65.5	53.0	66.8	58.6	8.2	......
6	April 28–May 25..	60.7	55.2	66.4	48.9	53.3	43.7	60.2	49.3	10.9	......
7	May 26–June 22...	60.7	55.2	54.3	45.8	50.7	47.0	55.5	49.3	6.2	......
8	June 23–July 20...	46.5	35.3	32.4	29.1	39.4	46.1	39.6	36.9	2.7	......
9	July 21–Aug. 17...	37.0	40.1	33.5	20.5	42.8	49.0	37.8	36.5	1.3	......
10	Aug. 18–Sept. 14..	23.0	32.4	28.1	12.3	42.8	45.7	31.3	30.2	1.1	......
11	Sept. 15–Oct. 12...	24.2	33.1	10.4	11.3	27.6	41.2	20.8	27.5	....	6.7
12	Oct. 13–Nov. 9....	10.2	10.3	4.8	6.1	6.0	11.9	7.0	9.9	....	2.9
13	Nov. 10–Dec. 7....	2.0	1.7	4.5	1.3	17.5	12.2	7.8	5.0	2.8	......
	True average...	35.6	36.3	33.2	25.7	36.0	32.7	35.0	31.9	3.1	......

The fluctuation in quantities of food consumed is illustrated in Fig. 163 and Table 6. These amounts vary more according to the season of the year than to the vigor of the individual. The greatest consumption begins in March and lasts through April (the spring months), falling off rapidly during May and reaching its lowest point in the autumn. Although the heaviest egg production occurs during the months of March, April, May, and June, the largest consumption of food slightly precedes this period and decreases more rapidly near the end of it.

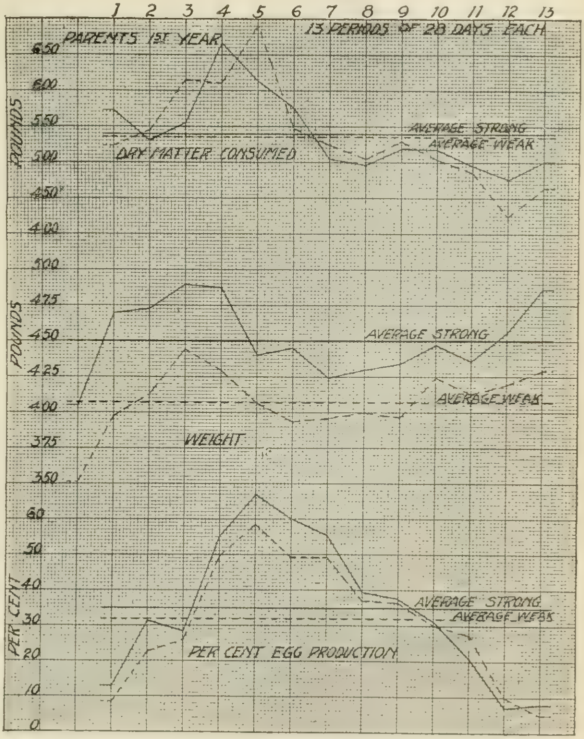

FIG. 163.—*The average dry matter consumed, the average weight of fowls, and the percentage of egg production, by periods of twenty-eight days each*

TABLE 6. AVERAGE DRY MATTER CONSUMED, AVERAGE WEIGHT OF FOWLS, AND PERCENTAGE OF EGG PRODUCTION, BY PERIODS

(December 10, 1907, to December 7, 1908)

Period	Date	Average dry matter consumed (pounds)		Average weight of fowls (pounds)		Percentage of egg production	
		Strong	Weak	Strong	Weak	Strong	Weak
	Beginning	......	......	4.05	3.51	......	....
1	December 10–January 6	5.72	5.23	4.70	3.95	12.9	8.5
2	January 7–February 3	5.38	5.47	4.73	4.13	31.5	22.6
3	February 4–March 2	5.59	6.17	4.88	4.44	28.2	26.0
4	March 3–March 30	6.73	6.13	4.85	4.30	55.1	49.6
5	March 31–April 27	6.19	6.94	4.41	4.07	66.8	58.6
6	April 28–May 25	5.84	5.49	4.46	3.93	60.2	49.3
7	May 26–June 22	5.11	5.26	4.24	3.96	55.5	49.3
8	June 23–July 20	4.99	5.05	4.30	4.00	39.6	36.9
9	July 21–August 17	5.29	5.35	4.34	3.97	37.8	36.5
10	August 18–September 14	5.27	5.04	4.48	4.24	31.3	30.2
11	September 15–October 12	4.99	4.87	4.36	4.13	20.8	27.5
12	October 13–November 9	4.83	4.24	4.56	4.17	7.0	9.9
13	November 10-December 7	5.08	4.63	4.86	4.29	7.8	5.0
Total		71.01	69.87	......	......	......	....
Average		5.46	5.37	4.51	4.07	35.0	31.9

The variation in weight also follows that of food consumption. The effect of heavy laying is to reduce the weight of the fowls. In December, when the egg production is low, the fowls gain rapidly in weight. When there is an increase in egg production there is a decrease in gain in weight, as shown in the months of January, March, and April. An increase in weight precedes an increase in production.

During the latter part of summer, when the food consumption is low, both the egg yield and the weight of the fowls are also low. This condition is materially influenced by the production of an entire new coat of feathers.

Weight of eggs

In Table 7 are shown the number and average weight of all the eggs produced during the last seven days of each monthly period. The eggs from both strong and weak pens weighed approximately the same. Fluctuations occurred in nearly every period, certain strong pens producing heavier eggs than the comparison weak pens and vice versa. In the yearly average the strong pens slightly exceeded, although this condition did not hold true in each of the comparison pens.

Cost per dozen eggs produced

The average cost per dozen, as determined by the cost of food divided by the number of eggs laid, was $0.12 for the strong pens and $0.131

TABLE 7. NUMBER OF EGGS FOR THE LAST SEVEN DAYS OF EACH PERIOD AND THEIR AVERAGE WEIGHTS IN GRAMS
(December 10, 1907, to December 7, 1908)

Period	Summer selected				Fall selected								True average			
	White Leghorns				White Leghorns				Barred Plymouth Rocks							
	Strong		Weak		Strong		Weak		Strong		Weak		Strong		Weak	
	Pen 78		Pen 79		Pen 76		Pen 75		Pen 21		Pen 23		78, 76, and 21		79, 75, and 23	
	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Weight	Number of eggs	Weight
1	84	48.4	81	46.8	54	53.6	39	53.6	......	......	......	......	46.0	50.4	40.0	49.0
2	168	50.8	214	51.4	37	55.9	13	53.7	......	......	......	......	68.3	51.7	75.7	51.5
3	29	52.5	70	55.5	......	......	......	......	50	56.0	38	51.6	26.3	54.2	36.0	54.1
4	88	56.5	88	56.0	102	58.9	72	57.6	81	57.9	69	51.2	90.3	57.8	76.3	55.0
5	104	53.6	98	55.7	108	59.0	76	57.1	116	57.0	82	52.7	109.3	56.5	85.3	55.1
6	107	54.5	71	54.7	103	57.4	55	56.2	83	54.9	61	51.0	97.7	55.6	62.3	53.9
7	116	50.8	78	53.7	52	53.6	31	55.7	75	56.3	61	51.0	81.0	53.1	56.7	53.0
8	68	56.1	53	55.4	28	55.0	22	58.1	52	58.2	62	52.9	49.3	56.6	45.7	54.6
9	62	56.4	53	56.9	36	59.9	8	51.2	72	56.7	69	53.5	56.7	57.2	43.3	54.7
10	33	57.0	49	57.2	22	58.2	9	55.3	78	57.5	69	54.6	44.3	57.5	42.3	55.6
11	28	58.7	34	57.5	7	56.7	13	56.8	15	58.6	41	54.5	16.7	58.2	29.4	55.8
12	11	61.5	6	59.0	5	61.6	......	......	7	54.5	10	58.8	7.7	59.9	5.3	59.2
13	2	59.5	1	62.0	7	61.7	14	59.4	51	61.3	34	56.4	20.0	61.2	16.4	57.1
Total	900	......	896	......	561	......	352	......	680	......	596	......	713.6	......	614.7	....
Av...	......	53.4	......	53.8	......	57.3	......	57.3	......	57.9	......	52.8	......	56.1	......	54.6

for the weak pens. (Table 8.) If the value gain in weight be deducted from the cost of food, the average cost per dozen is lowered to $0.108 for the strong and $0.117 for the weak. When value gain in weight is not allowed, the Barred Plymouth Rock eggs cost more per dozen than the Leghorns, by virtue of the larger amount of food consumed by the fowls. If the cost of eggs be lessened by the value gain in weight, the Plymouth Rocks produced eggs at as low a cost per dozen as the Leghorns.

TABLE 8. COST PER DOZEN EGGS PRODUCED
(December 10, 1907, to December 7, 1908)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	....	....	....	....
Cost of food per dozen eggs	$0.108	$0.122	$0.116	$0.136	$0.137	$0.143	$0.120	$0.131	....	$0.011
Cost of food minus value gain in weight per dozen eggs	0.103	0.115	0.112	0.132	0.111	0.110	0.108	0.117	....	0.009

Incubation

The incubation of several hundred eggs per flock showed some advantage in fertility and hatching power in favor of the strong pens. The fertility was better and the number of chicks hatched was larger. The number hatched in proportion to fertile eggs, also, was slightly larger in the strong pens. (Table 9.) The average weight of the chicks was greater for

TABLE 9. INCUBATION REPORT
(December 10, 1907, to December 7, 1908)

	Summer selected		Fall selected				True average		Difference
	White Leghorns		White Leghorns		Barred Plymouth Rocks				
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong
Pen	78	79	76	75	21	23	....	....	......
Number of eggs set	1,007	1,013	368	229	308	259	561	500	61
Percentage of fertile eggs	88.3	84.2	85.6	70.2	83.4	69.5	86.8	79.5	7.3
Percentage of eggs hatched to fertile eggs	69.6	67.5	63.1	59.0	54.8	48.3	65.6	63.4	2.2
Percentage of eggs hatched to number set	61.5	56.8	54.0	41.5	45.8	33.6	57.0	50.4	6.6
Average weight of chicks hatched (pounds)	0.078	0.079	0.079	0.076	0.071	0.067	0.078	0.077	0.001
Average weight of eggs set (pounds)	0.119	0.119	0.127	0.123	0.124	0.113	0.121	0.119	0.002

the strong pens. The Barred Plymouth Rock pens gave a smaller percentage of chicks to the number of eggs set than did either of the Leghorn pens. The White Leghorn day-old chicks were heavier than the Plymouth Rock chicks, although the eggs in the strong Plymouth Rock pens were heavier than the eggs in some of the pens of White Leghorns. This seems to indicate a negative correlation between size of chick and breed, and size of egg.

Development of the chicks

The chickens from all the fowls, weak and strong, were brooded together. This insured similar conditions and an equal chance of development for all.

The mortality up to six weeks of age was slightly greater among the chicks from the strong pens, which could not be accounted for by the appearance of the chickens. Among both weak and strong the mortality was much heavier with the Leghorns than with the Plymouth Rocks. (Table 10.)

TABLE 10. CHICK RECORD

(December 10, 1907, to December 7, 1908)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	......	......	......	......
Number of chicks living at the end of six weeks	390	366	113	63	112	81	205	170	35	......
Percentage mortality up to six weeks of age	34.7	35.3	32.7	13.7	17.0	3.5	31.7	29.4	2.3	......
Percentage males	22.8	24.2	39.1	27.1	29.4	20.4	30.4	23.9	6.5	......
Percentage females	25.2	27.3	49.3	24.2	23.5	40.9	32.6	30.8	1.8	......
Percentage sex not recorded	52.0	48.5	11.6	48.7	47.1	38.7	37.0	45.3	......	8.3
Average weight of pullets at maturity (pounds)	3.0	3.05	3.07	2.45	4.53	3.48	3.53	2.99	0.54	......

The percentage of chicks at the end of six weeks to the total number of eggs set was slightly to the advantage of the strong pens. It is also noticeable that, although the mortality among the Plymouth Rocks was much less than among the Leghorns, it still required more eggs to produce one Plymouth Rock than to produce one Leghorn (2.8 eggs for each Leghorn chicken and 2.9 eggs for each Plymouth Rock chicken at six weeks of age).

When penned up in the fall the average weight of the pullets from the strong pens (3.53 pounds) greatly exceeded that of the pullets from the weak pens (2.99 pounds). This difference was greatest with the

Plymouth Rocks. Although the mortality among the chickens from pen 76 (strong) was much heavier than among the chickens from pen 75 (weak), the pullets in pen 76 were much heavier, their average weight being 3.07 pounds while that of the pullets in pen 75 was 2.45 pounds.

Owing to the different combinations of weak and strong fowls used, records were kept of the sex of the progeny. There were a good many deaths of young chicks whose sex was not recorded. Neither was the sex recorded of the chicks that failed to hatch. In Table 10, however, is shown the percentage of cockerels and pullets of all the chicks recorded. All the strong pens, which had strong females and strong males, produced about an even percentage of cockerels and pullets. There were natural fluctuations, the difference in pen 76 being as great as ten per cent more pullets, and in pen 21, six per cent more cockerels. Among the weak pens the pullets averaged seven per cent greater in number than the cockerels. However, in pen 75 (weak females and weak males) the cockerels outnumbered the pullets by nearly three per cent. In the other two weak pens (strong males with weak females) the pullets outnumbered the cockerels. This was especially true with the Plymouth Rock pen 23.

It would seem from these more or less contradictory results that the strength of the breeding stock does not greatly influence the sex of the offspring.

Financial statement

The financial statement for the year means the difference between the value of eggs laid plus the value of the gain in weight of the fowls, and the cost of food plus the cost of loss of stock by death. The interest on the investment is not included. The cost of litter for the pens is

TABLE 11. FINANCIAL STATEMENT PER HEN

(December 10, 1907, to December 7, 1908)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	....	......	....	......
Value of eggs	$2.95	$3.05	$2.80	$1.95	$3.01	$2.74	$2.92	$2.59	$0.33	......
Value of gain in weight	0.05	0.07	0.05	0.03	0.28	0.32	0.13	0.14	....	$0.01
Cost of food	1.17	1.35	1.18	1.07	1.50	1.42	1.28	1.28	....	......
Cost of loss of stock	0.00	0.10	0.06	0.23	0.11	0.06	0.06	0.13	....	0.07
Total income	3.00	3.12	2.85	1.98	3.29	3.06	3.05	2.73	0.32	......
Total outgo	1.17	1.45	1.24	1.30	1.61	1.48	1.34	1.41	....	0.07
Balance profit	1.83	1.67	1.61	0.68	1.68	1.58	1.71	1.32	0.39	......

more than offset by the manure taken from them. The labor involved in keeping records was so greatly in excess of what it would be on a commercial plant that it was omitted from this summary.

In Table 11 the balance profit from each of the strong pens is shown to be materially greater than that from the corresponding weak pen. This difference is most pronounced in the fall-selected White Leghorn pens. Although the weak pen (79) laid more eggs than the strong pen (78), the difference in consumption of food and the cost of lost stock brought the average profit of flock 79 sixteen cents lower than that of flock 78. The difference in balance profit between the averages of the strong and weak pens was thirty-nine cents in favor of the strong pens.

PART II

THE SECOND YEAR'S WORK WITH THE ORIGINAL FOWLS

The second part of this bulletin is concerned with the data obtained during the second year of work on the fowls used in the experiments described in Part I. The same fowls were continued in the same pens under similar care and treatment.

FOOD CONSUMPTION

The consumption of whole grain was noticeably less during the second year. This was due to the heavy consumption of ground feed. The consumption of the latter, however, was much more evenly distributed among the different pens. The strong pens averaged a larger consumption of total food during the second year. The fowls in the strong pens ate a slightly less amount of whole grain, on the average, than did those in the weak pens. The consumption of meat scrap was greater in the strong pens, because of the greater use of the dry mash in those pens. (Table 12.)

TABLE 12. CONSUMPTION OF FOOD PER HEN (IN POUNDS)
(December 8, 1908, to December 6, 1909)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	......	......	......	......
Total, including grit and shell	82.50	81.24	79.44	77.20	114.37	104.83	91.12	89.02	2.10	......
Total, not including grit and shell	75.80	77.08	76.92	74.85	109.78	100.87	86.39	85.45	0.94	......
Total whole grain	38.80	42.87	42.58	45.03	60.70	56.44	46.59	48.63	....	2.04
Total ground grain	16.81	12.95	15.47	11.00	17.32	16.39	16.53	13.69	2.84	......
Total whole and ground grain	55.61	55.82	58.05	56.03	78.02	72.83	63.12	62.32	0.80	......
Total grit and shell	6.70	4.16	2.52	2.35	4.59	3.96	4.73	3.57	1.16	......
Pounds of whole grain to each pound of ground grain	2.30	3.31	2.75	4.09	3.50	3.44	2.81	3.55	....	0.74
Percentage of meat scrap to grain	9.22	7.59	8.11	5.96	6.66	6.90	8.09	6.86	1.23	......
Pounds of other foods to each pound of grit and shell	11.31	18.52	30.52	31.85	23.91	25.47	18.26	23.93	....	5.67

In most instances the flock that produced the largest number of eggs consumed the greatest amount of meat scrap and dry mash. The amount of grit and shell eaten the second year was about the same as the first. The stronger fowls ate the greater amount of grit and shell.

Owing to the change in relative proportion of the consumption of whole grain and dry mash (containing the meat scrap), the ratio of protein to carbohydrates was narrower during the second year of feeding. (Table 13.) This may partially account for the fact that the production of eggs per pound of dry matter consumed remained as low for the yearling fowls as for the pullets.

TABLE 13. TOTAL FOOD NUTRIENTS (IN POUNDS)
(December 8, 1908, to December 6, 1909)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	....	......	....	......
Dry matter	57.23	56.83	58.97	55.99	78.53	73.20	64.19	62.79	1.40	......
Ash (including grit and shell)	8.66	6.05	4.46	4.14	7.11	6.28	6.85	5.58	1.27	......
Protein	9.58	8.94	9.47	8.24	11.84	11.13	10.22	9.74	0.48	......
Carbohydrates	36.40	37.01	38.15	37.30	53.09	48.12	42.75	41.30	1.45	......
Fat	2.44	3.78	2.46	2.20	3.15	2.96	2.65	3.01	....	0.36
Ratio of protein to carbohydrates and fat	4.37	5.09	4.61	5.12	5.08	4.92	4.76	4.93	....	0.17

The amount of dry matter consumed per pound live weight was several pounds less during the second year of feeding than during the first. (Table 14.) Eggs were produced, also, at practically the same expenditure of dry matter as during the preceding year. Although the same number of eggs was produced the second year, for each one hundred pounds of dry matter consumed a smaller total number of eggs was produced.

TABLE 14. THE PROPORTIONATE CONSUMPTION OF FOOD PER POUND LIVE WEIGHT AND PER POUND EGGS PRODUCED
(December 8, 1908, to December 6, 1909)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	....	......	....	......
Pounds dry matter consumed per pound live weight	14.34	15.11	14.48	14.46	11.70	12.34	13.29	13.61	....	0.32
Pounds dry matter required per pound eggs produced	4.15	4.34	4.41	4.68	5.84	5.25	4.71	4.82	....	0.11
Pounds of food required to produce 1 dozen eggs	8.96	9.30	8.91	9.68	12.76	11.28	10.02	10.26	....	0.24

BROODINESS AND MORTALITY

The number of fowls that became broody during the second year, as shown in Table 15, did not exceed that of the first year to any extent, but the length of time during which they remained broody did materially exceed that of the first year.

TABLE 15. BROODINESS AND MORTALITY
(December 8, 1908, to December 6, 1909)

	Summer selected		Fall selected				Total		Difference
	White Leghorns		White Leghorns		Barred Plymouth Rocks				
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong
Pen	78	79	76	75	21	23	....	......	....
Number of hens broody	21	23	22	20	60	51	103	94	9
Days broody	184	184	156	155	401	314	741	653	88
Number died	1	2	5	2	6	2	12	6	6
Percentage mortality	4	9.5	21.7	11.1	27.2	8.6	....	......	....

The high mortality in two of the strong pens was unexpected and in no way accountable. The fowls that died showed no signs of disease and to all appearances they did not die from physical weakness. Notwithstanding this, the average mortality for the two years was a little heavier in the weak pens.

EGG PRODUCTION

The egg production averaged higher for the strong pens although there was great fluctuation at different periods, during some of which

TABLE 16. PERCENTAGE OF EGG PRODUCTION BY PERIODS
(December 8, 1908, to December 6, 1909)

Period	Date	Summer selected		Fall selected				True average		Difference	
		White Leghorns		White Leghorns		Barred Plymouth Rocks					
		Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
		Pen 78	Pen 79	Pen 76	Pen 75	Pen 21	Pen 23	....	......	....	......
1	Dec. 8–Jan. 4	0.5	2.3	3.2	2.1	28.0	13.3	10.1	6.3	3.8	......
2	Jan. 5–Feb. 1	9.7	8.1	4.5	3.9	24.6	24.8	12.6	13.1	....	0.5
3	Feb. 2–Mar. 1	17.4	21.2	20.6	14.0	19.0	22.6	18.9	19.7	....	0.8
4	Mar. 2–Mar. 29	40.5	37.5	36.5	43.0	44.7	44.4	40.3	41.8	....	1.5
5	Mar. 30–April 26	62.8	65.4	62.3	63.8	40.4	47.5	55.9	57.9	....	2.0
6	April 27–May 24	66.2	60.5	60.5	56.8	43.2	45.3	57.4	53.5	3.9	......
7	May 25–June 21	58.4	59.7	54.9	46.8	43.3	43.0	52.7	49.5	3.2	......
8	June 22–July 19	52.0	45.8	51.5	39.5	34.2	38.3	46.1	41.1	5.0	......
9	July 20–Aug. 16	39.7	28.9	33.8	36.1	36.2	37.0	36.8	34.0	2.8	......
10	Aug. 17–Sept. 13	33.3	24.8	34.3	26.3	38.8	40.4	35.2	31.1	4.1	......
11	Sept. 14–Oct. 11	12.9	14.2	18.0	7.5	22.7	31.9	17.2	18.7	....	1.5
12	Oct. 12–Nov. 8	....	5.4	1.5	1.1	7.8	9.2	4.5	5.5	....	1.0
13	Nov. 9–Dec. 6	....	......	....	......	0.9	0.3	0.9	0.3	0.6	......
	True average	30.29	28.78	29.37	26.28	29.56	30.64	29.74	28.57	1.17	......

the production from the weak pens was the larger. At two periods only was the production as great as that of the first year, although it compared very favorably during the months of March, April, May, June, and July. There were certain periods during the late fall when some of the flocks produced no eggs. (Table 16.)

The second year's tabulation of average consumption of dry matter, weight of fowls, and production of eggs by periods shows practically the same conditions as existed during the first year. The period of heaviest weight of the fowls in each case precedes the period of highest egg production. The periods of highest consumption of dry matter come at the same time as those of heaviest egg production. The average strong and average weak pens show a very similar type of curve. The strong pens during most periods show better egg production and food consumption than do the weak pens. The weak fowls reached their highest production in the spring one period in advance of the strong, and started laying a little earlier in the fall than did the strong. These conditions are shown in Table 17 and Fig. 164.

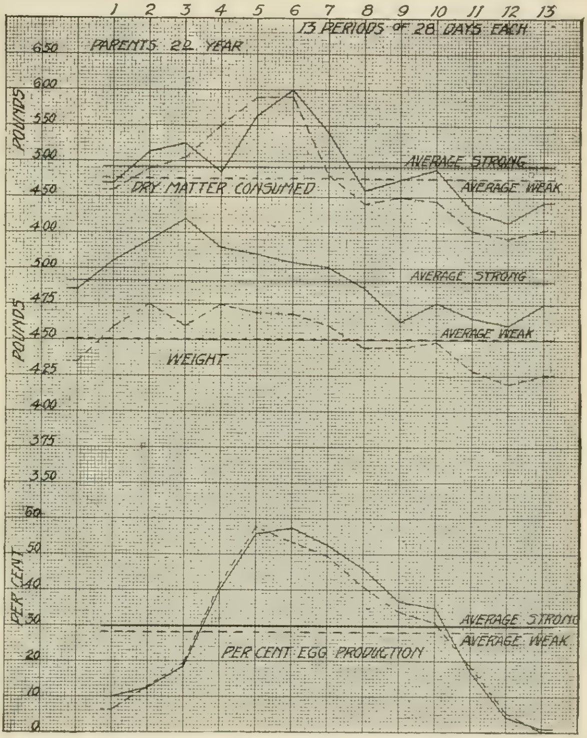

FIG. 164.—*The average dry matter consumed, the average weight of fowls, and the percentage of egg production, by periods of twenty-eight days each*

WEIGHT OF EGGS

The average weight of the eggs incubated from the strong flocks was slightly greater than that of the eggs from the weak flocks. (Table 18.) For both years the difference in weight between the eggs from the strong and weak flocks of Barred Plymouth Rocks was greater than between those from the strong and weak Leghorn flocks.

TABLE 17. AVERAGE DRY MATTER CONSUMED, AVERAGE WEIGHT OF FOWLS, AND PERCENTAGE OF EGG PRODUCTION, BY PERIODS

(December 8, 1908, to December 6, 1909)

Period	Date	Average dry matter consumed (pounds)		Average weight of fowls (pounds)		Percentage of egg production	
		Strong	Weak	Strong	Weak	Strong	Weak
	Beginning	......	......	4.86	4.29	......	....
1	December 8–January 4	4.70	4.61	5.06	4.59	10.1	6.3
2	January 5–February 1	5.15	4.96	5.21	4.76	12.6	13.1
3	February 2–March 1	5.26	5.12	5.35	4.61	18.9	19.7
4	March 2–March 29	4.87	5.58	5.15	4.75	40.3	41.8
5	March 30–April 26	5.65	5.95	5.09	4.69	55.9	57.9
6	April 27–May 24	6.02	5.97	5.04	4.68	57.4	53.5
7	May 25–June 21	5.39	4.89	5.01	4.60	52.7	49.5
8	June 22–July 19	4.58	4.49	4.86	4.44	46.1	41.1
9	July 20–August 16	4.75	4.57	4.63	4.45	36.8	34.0
10	August 17–September 13	4.89	4.52	4.77	4.48	35.2	31.1
11	September 14–October 11	4.34	4.10	4.66	4.29	17.2	18.7
12	October 12–November 8	4.16	3.99	4.61	4.19	4.5	5.5
13	November 9–December 6	4.43	4.04	4.75	4.27	0.9	0.3
Total		64.19	62.79	......	......	......	....
Average		4.93	4.83	4.92	4.52	29.74	28.57

COST PER DOZEN EGGS PRODUCED

The average cost to produce eggs the second year was three to five cents more per dozen than for the first year. (Table 19.) This increased cost is accounted for by the lower consumption of food and higher production of eggs during the previous year. The weak Plymouth Rock pen made a more economical use of its food in number of eggs produced, but the strong fowls produced much heavier eggs. This comparison is the only one in this series in which the weak fowls produced at a lower cost per dozen eggs.

INCUBATION

A large number of eggs were incubated and showed a consistent advantage in favor of the strong pens, not only in fertility, but in the percentage of eggs hatched, weight of chicks, and number of chicks alive at the end of six weeks. In hatching power, the eggs from the strong pens averaged 7.7 per cent higher than those from the weak pens. There was less difference in the weight of the chicks from the strong and weak White Leghorn pens than in that from the strong and weak Plymouth Rock pens. The weight of the chick seems to depend more on the weight of the egg than on the flock or breed from which it was hatched. In two

TABLE 18. NUMBER OF EGGS FOR THE LAST SEVEN DAYS OF EACH PERIOD AND THEIR AVERAGE WEIGHTS IN GRAMS
(December 8, 1908, to December 6, 1909)

Period	Summer selected				Fall selected								True average			
	White Leghorns				White Leghorns				Barred Plymouth Rocks							
	Strong		Weak		Strong		Weak		Strong		Weak		Strong		Weak	
	Pen 78		Pen 79		Pen 76		Pen 75		Pen 21		Pen 23		78, 76, and 21		79, 75, and 23	
	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Weight	Number of eggs	Weight
1	23	61.9	6	63.5	1	60.0	9	58.7	47	63.3	18	54.1	23.7	62.8	11.0	57.1
2	39	60.4	18	59.3	20	60.2	18	60.9	49	62.8	55	57.7	36.0	61.5	30.3	58.6
3	101	59.9	34	59.4	43	61.1	63	60.7	15	56.8	44	56.4	53.0	59.9	47.0	59.0
4	115	57.4	71	60.5	69	61.3	66	58.7	73	63.3	71	56.4	85.6	60.1	69.3	58.5
5	128	57.7	90	57.8	99	59.7	67	60.1	37	58.8	61	55.9	88.0	58.6	72.6	58.0
6	95	56.1	77	57.7	88	58.6	54	57.5	54	60.3	61	56.5	79.0	58.0	64.0	57.3
7	93	56.5	76	56.3	59	57.5	42	57.3	70	59.3	65	53.3	74.0	57.6	61.0	55.5
8	65	57.1	48	54.4	72	55.8	40	56.2	49	59.0	52	54.2	62.0	57.1	46.7	54.8
9	46	56.1	27	58.8	49	53.8	20	57.4	44	60.6	57	55.9	46.3	56.7	34.7	56.9
10	6	58.1	37	55.7	38	55.5	4	59.2	31	59.3	61	55.5	25.0	57.3	34.0	55.7
11	......	......	12	54.7	16	55.5	1	51.0	20	59.8	37	53.8	12.0	57.9	16.7	54.0
12	......	......	......	......	......	......	......	......	3	61.6	5	58.4	1.0	61.6	1.7	58.4
13	......	......	......	......	......	......	......	......	2	57.5	......	......	.7	57.5	......	......
Total..	711	......	496	......	554	......	384	......	494	......	587	......	586.3	......	489.0	......
Av.....	......	57.7	......	57.7	......	58.1	......	58.7	......	60,7	......	55.6	......	58.7	......	57.1

TABLE 19. COST PER DOZEN EGGS PRODUCED
(December 8, 1908, to December 6, 1909)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	....	....	....	....
Cost of food per dozen eggs	$0.133	$0.139	$0.140	$0.149	$0.186	$0.170	$0.150	$0.153	....	$0.003
Cost of food minus value gain in weight per dozen eggs	0.132	0.137	0.143	0.149	0.189	0.177	0.152	0.155	....	0.003

cases the strong flock laid the heavier eggs and these hatched the heavier chicks; but in one combination flock 79 (weak) produced the heavier eggs and consequently heavier chicks. (Table 20.)

TABLE 20. INCUBATION REPORT
(December 8, 1908, to December 6, 1909)

	Summer selected		Fall selected				True average		Difference
	White Leghorns		White Leghorns		Barred Plymouth Rocks				
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong
Pen	78	79	76	75	21	23	....	....	....
Number of eggs set	331	346	298	273	256	267	295	295	....
Percentage of fertile eggs	84.2	62.7	90.6	92.3	87.5	88.4	87.3	79.5	7.8
Percentage of eggs hatched to fertile eggs	41.9	40.0	39.6	33.7	32.1	23.7	38.3	32.3	6.0
Percentage of eggs hatched to number set	35.3	25.1	35.9	31.1	28.1	21.0	33.4	25.7	7.7
Average weight of chicks hatched (pounds)	0.087	0.088	0.090	0.088	0.085	0.081	0.088	0.086	0.002
Average weight of eggs set (pounds)	0.129	0.130	0.133	0.131	0.133	0.123	0.130	0.128	0.002

CHICK MORTALITY

The actual number of chicks alive at the end of six weeks was greater in each instance in the strong pens than in the weak. The percentage of mortality was higher in the weak pens except with the White Leghorn fall-selected flocks, in which case the weak pen had a slightly lower mortality percentage than the strong. The average for all flocks, however, was greatly to the advantage of the strong pens. (Table 21.)

A larger percentage of heavier chicks was hatched in pen 76 (strong) than in pen 75 (weak); but the greater percentage of mortality occurred in this same strong pen with both chicks and old fowls. It does not follow then, necessarily, that the chicks produced from eggs which hatched more and heavier chicks than other eggs, will survive better.

In the same season the mortality in pens 21 (strong) and 23 (weak) was greater among the chicks in the weak pen, whereas the mortality in the parent stock was greater among the hens in the strong pen. This shows that the rate of mortality in the parent stock does not necessarily influence the death rate in the chicks.

TABLE 21. CHICK RECORD

(December 8, 1908, to December 6, 1909)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	......	......	......	......
Number of chicks living at the end of six weeks	79	44	78	63	51	26	69	44	25	......
Percentage mortality up to six weeks of age	30.1	31.2	24.2	20.2	28.1	51.8	27.6	32.5	......	4.9
Percentage males	12.9	10.9	14.6	10.1	17.6	24.1	13.5	14.2	......	0.7
Percentage females	7.8	12.5	6.8	5.1	17.6	27.8	8.6	13.7	......	5.1
Percentage sex not recorded	79.3	76.6	78.6	84.8	64.8	48.1	77.9	72.1	5.8	......
Average weight of pullets at maturity (pounds)	......	......	2.98	2.96	......	......	2.98	2.96	0.02	......

FINANCIAL STATEMENT

The financial statement shown in Table 22 was computed in the same way as that in Part I. Among the White Leghorns, the value of the eggs produced from the strong pens and the balance profit for those pens materially exceeded the record for the weak pens. It was different,

TABLE 22. FINANCIAL STATEMENT PER HEN

(December 8, 1908, to December 6, 1909)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78	79	76	75	21	23	......	......	......	......
Value of eggs	$2.60	$2.47	$2.55	$2.23	$2.66	$2.78	$2.60	$2.53	$0.07	......
Value of gain in weight	0.01	0.02	......	......	......	......	0.003	0.006	......	$0.003
Cost of loss in weight	......	......	0.03	0.005	0.03	0.07	0.02	0.025	......	0.005
Cost of food	1.25	1.22	1.25	1.19	1.67	1.58	1.37	1.34	0.03	......
Cost of loss of stock	0.02	0.06	0.16	0.08	0.33	0.08	0.16	0.08	0.08	......
Total income	2.61	2.49	2.55	2.23	2.66	2.78	2.603	2.536	0.067	....
Total outgo	1.27	1.28	1.44	1.275	2.03	1.73	1.55	1.445	0.105	......
Balance profit	1.34	1.21	1.11	0.955	0.63	1.05	1.053	1.091	......	0.038

however, with the Plymouth Rocks. In that case the weak pen greatly exceeded the strong pen in the profit at the end of the year. This condition is due principally to the high mortality in strong pen 21. The cause of this mortality seems to have affected also the production of the remaining strong fowls, as shown by their product falling below the value of the weak pen. This difference between the strong and weak Plymouth Rocks was sufficient to bring the true average balance profit of all the strong pens below that of the weak, even though the average value of the eggs produced by the strong was the greater. In omitting the loss by death from these calculations the strong pens would show a decided profit over the weak, instead of a loss.

It is interesting to note that although the Plymouth Rock hens, strong and weak, laid more eggs during the second year than did the White Leghorns, yet because of the lower food consumption the Leghorns materially exceeded the Plymouth Rocks in the actual balance profit.

The value of the eggs from the second year of feeding was nearly as great as that from the first, and with the food consumption about the same the balance profit should have been nearly equal for both years. The increased price in grain during the second year, however, made the balance profit less than that of the first year.

PART III

THE PROGENY FROM THE ORIGINAL FLOCKS

The third part of this bulletin records the observations made on the progeny from the pullets in the original pens. All the pullets matured from the weak flocks were saved. If the number in the strong flocks exceeded that in the weak, they were culled to an equal number. No further selection was made. Two weak males (cockerels) were put in pen 13 (weak). In all the other pens strong males were used. In general care and management the treatment of these flocks was similar to that of their parents.

FOOD CONSUMPTION

The second generation consumed more food per fowl than did the first generation. In every instance the food consumption was greater in the strong pen, and the average consumption of ground food was of about the same proportion as it was with the first generation. In each instance, except the fall-selected White Leghorns, the strong flocks consumed the greater amount of ground food. Since the mash contained the meat scrap, this weak flock (13) consequently consumed more of the meat than did the corresponding strong flock. This fact may partially explain

TABLE 23. CONSUMPTION OF FOOD PER HEN (IN POUNDS)
(November 24, 1908, to November 22, 1909)

	Progeny from summer selected		Progeny from fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	20	22	11	13	12	14	......	......	......	......
Parents' pen	78	79	76	75	21	23	......	......	......	......
Total, including grit and shell	85.85	80.13	86.29	85.04	110.03	104.85	92.84	87.00	5.84	......
Total, not including grit and shell	81.84	77.33	80.18	78.98	105.17	97.04	88.29	82.45	5.84	......
Total whole grain	41.54	41.08	46.28	42.50	58.03	59.81	46.94	45.92	1.02	......
Total ground grain	16.77	15.18	13.46	15.60	20.03	13.20	17.23	14.76	2.47	......
Total whole and ground grain	58.31	56.26	59.74	58.10	78.06	73.01	64.17	60.68	3.49	......
Total grit and shell	4.01	2.80	6.11	6.06	4.86	7.81	4.55	4.55	0.00	......
Pounds of whole grain to each pound of ground grain	2.47	2.70	3.43	2.72	2.89	4.53	2.72	3.11	......	0.39
Percentage of meat scrap to grain	9.44	8.86	8.40	9.50	8.81	6.39	8.87	8.10	0.77	......
Pounds of other foods to each pound of grit and shell	20.40	27.61	13.12	13.03	21.63	12.42	19.40	18.12	1.28	......

the higher percentage of egg production in pen 13 (weak) over pen 11 (strong). In all other comparison flocks, as well as in the averages of all the strong and weak flocks, the strong flocks consumed more meat scrap and produced more eggs than did the weak flocks. This higher production in the pens consuming the greater proportion of meat scrap to grain is true in all three parts of these experiments. The ratio of protein to carbohydrates and fat varied in the same proportion and in the same pens according to the consumption of mash and meat scrap and the production of eggs. When the ratio was narrowest, the egg production was greatest. The average ratio for the best production was about 1:4.5.

TABLE 24. TOTAL FOOD NUTRIENTS (IN POUNDS)

(November 24, 1908, to November 22, 1909)

	Progeny from summer selected		Progeny from fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	20	22	11	13	12	14	......	......	....	......
Parents' pen	78	79	76	75	21	23	......	......	....	......
Dry matter	60.24	57.78	60.65	59.46	79.26	72.87	65.75	61.76	3.99	......
Ash (including grit and shell)	6.49	4.75	8.05	8.00	7.40	10.07	6.97	6.58	0.39	......
Protein	10.11	9.51	9.72	9.92	12.91	10.81	10.86	9.89	0.97	......
Carbohydrates	38.29	43.47	39.31	37.54	50.87	48.43	42.06	43.75	....	1.69
Fat	2.58	2.44	2.55	3.24	3.51	4.37	2.84	3.04	....	0.20
Ratio of protein to carbohydrates and fat	4.36	5.14	4.63	4.52	4.55	5.39	4.46	5.12	....	0.66

TABLE 25. THE PROPORTIONATE CONSUMPTION OF FOOD PER POUND LIVE WEIGHT AND PER POUND EGGS PRODUCED

(November 24, 1908, to November 22, 1909)

	Progeny from summer selected		Progeny from fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	20	22	11	13	12	14	....	......	....	......
Parents' pen	78	79	76	75	21	23	....	......	....	......
Pounds dry matter consumed per pound live weight	17.92	17.66	18.26	19.05	13.59	14.54	15.99	16.67	....	0.68
Pounds dry matter required per pound eggs produced	3.43	3.65	4.12	3.88	5.10	6.50	4.18	4.48	....	0.30
Pounds of food required to produce 1 dozen eggs	7.34	7.60	8.79	8.34	10.63	14.03	8.85	9.55	....	0.70

In Table 25 it is shown that more pounds of food per pound live weight were required by the weaker flocks, except for the progeny of the summer-selected White Leghorns. The number of pounds of dry matter required to produce a pound of eggs varied in proportion to the consumption of meat scraps rather than to the consumption of food. The pounds of feed required to produce each dozen of eggs varied in like manner.

BROODINESS AND MORTALITY

It is shown in Table 26 that the strong fowls were broody more frequently than the weak ones. This was true in all but one comparison. The same condition existed in the parent stock during the pullet year, but changed during the second year to such an extent that the weak ones were broody more frequently.

TABLE 26. BROODINESS AND MORTALITY

(November 24, 1908, to November 22, 1909)

	Progeny from summer selected		Progeny from fall selected				Total		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	20	22	11	13	12	14	......	......	......	......
Parents' pen	78	79	76	75	21	23	......	......	......	......
Number of hens broody	13	1	10	3	29	35	52	39	13	......
Days broody	75	13	114	27	116	196	305	236	69	......
Number died	4	1	3	2	2	4	9	7	2	......
Percentage mortality	12.5	3	33.3	22.2	13.3	26.6	......	......	......	......

The mortality was higher in the two strong White Leghorn pens than in the weak, but was lower in the strong Barred Plymouth Rock pen than in the corresponding weak pen. There was no apparent cause for this mortality. The percentage of mortality to which we would naturally look as an indication of constitutional vigor was very uneven and irregular in all the pens in the three experiments. Instead of assisting, it made the interpretation of these results more difficult.

EGG PRODUCTION

The average egg production is decidedly in favor of the strong flocks. (Table 27.) In one comparison, however, pen 11 (weak) produced more than pen 11 (strong), due to an unusual laying rally during July, August, and September. The parents of this flock were considered the weakest of all flocks and the males used were also weak individuals. The pullets themselves were lighter and less developed in the fall.

TABLE 27. PERCENTAGE OF EGG PRODUCTION BY PERIODS
(November 24, 1908, to November 22, 1909)

Period	Date	Progeny from summer selected		Progeny from fall selected				True average		Difference	
		White Leghorns		White Leghorns		Barred Plymouth Rocks					
		Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
		Pen 20	Pen 22	Pen 11	Pen 13	Pen 12	Pen 14	......	......	......	......
		Parents' pen 78	Parents' pen 79	Parents' pen 76	Parents' pen 75	Parents' pen 21	Parents' pen 23	......	......	......	......
1	November 24–December 21	20.8	29.6	19.0	8.7	4.2	....	16.0	25.0	......	9.0
2	December 22–January 18	21.2	26.1	11.5	15.0	19.0	2.5	19.0	18.1	0.9	....
3	January 19–February 15	31.7	35.4	36.9	26.1	26.1	16.0	31.0	28.9	2.1	....
4	February 16–March 15	45.5	45.9	38.0	32.5	19.7	11.4	37.2	34.7	2.5	....
5	March 16–April 12	55.1	51.7	37.0	31.7	27.8	7.0	44.8	36.9	7.9	....
6	April 13–May 10	64.5	47.9	61.9	52.7	57.6	29.6	62.2	44.2	18.0	....
7	May 11–June 7	71.1	51.4	67.8	62.6	58.1	36.2	67.0	49.6	17.4	....
8	June 8–July 5	60.0	51.4	47.6	46.4	50.7	45.0	55.6	49.1	6.5	....
9	July 6–August 2	50.1	48.0	29.7	46.7	39.0	42.5	44.2	46.5	......	2.3
10	August 3–August 30	46.0	40.2	42.2	50.5	45.1	45.5	45.2	42.9	2.3	....
11	August 31–September 27	29.1	21.3	25.0	43.8	50.2	45.1	34.8	30.1	4.7	....
12	September 28–October 25	4.3	2.4	2.9	19.8	31.8	32.4	12.3	11.6	0.7	....
13	October 26–November 22	1.5	0.4	0.5	......	14.1	6.4	5.1	2.0	3.1	....
	True average	38.6	34.8	32.3	33.6	34.2	24.6	35.0	31.0	4.0	....

TABLE 28. AVERAGE DRY MATTER CONSUMED, AVERAGE WEIGHT OF FOWLS, AND PERCENTAGE OF EGG PRODUCTION, BY PERIODS
(November 24, 1908, to November 22, 1909)

Period	Date	Average dry matter consumed (pounds)		Average weight of fowls (pounds)		Percentage of egg production	
		Strong	Weak	Strong	Weak	Strong	Weak
	Beginning	......	......	3.53	2.98	......	......
1	November 24–December 21	5.08	4.89	4.06	3.58	16.0	25.0
2	December 22–January 18	5.35	5.12	4.35	3.98	19.0	18.1
3	January 19–February 15	5.50	5.32	4.63	4.26	31.0	28.9
4	February 16–March 15	5.64	5.61	4.62	4.27	37.2	34.7
5	March 16–April 12	5.38	5.32	4.09	4.04	44.8	36.9
6	April 13–May 10	5.64	5.74	4.29	3.78	62.2	44.2
7	May 11–June 7	6.13	5.23	4.24	3.92	67.0	49.6
8	June 8–July 5	5.19	4.87	4.09	3.67	55.6	49.1
9	July 6–August 2	4.58	4.67	4.13	3.76	44.2	46.5
10	August 3–August 30	4.69	4.74	4.20	3.88	45.2	42.9
11	August 31–September 27	4.79	4.34	4.13	3.61	34.8	30.1
12	September 28–October 25	4.19	4.01	3.90	3.65	12.3	11.6
13	October 26–November 22	4.54	4.30	4.17	3.90	5.1	2.0
Total		66.70	63.16	......	......	......	......
Average		5.13	4.86	4.22	3.80	35.0	31.0

A study of Table 28 and Fig. 165 shows that the heavy consumption of food in these pullet pens occurred during the periods of heaviest weight of the fowls and slightly preceded the highest production of eggs. These figures confirm the data given in Table 6 and Fig. 163, Part I, and in Table 17 and Fig. 164, Part II, of this bulletin.*

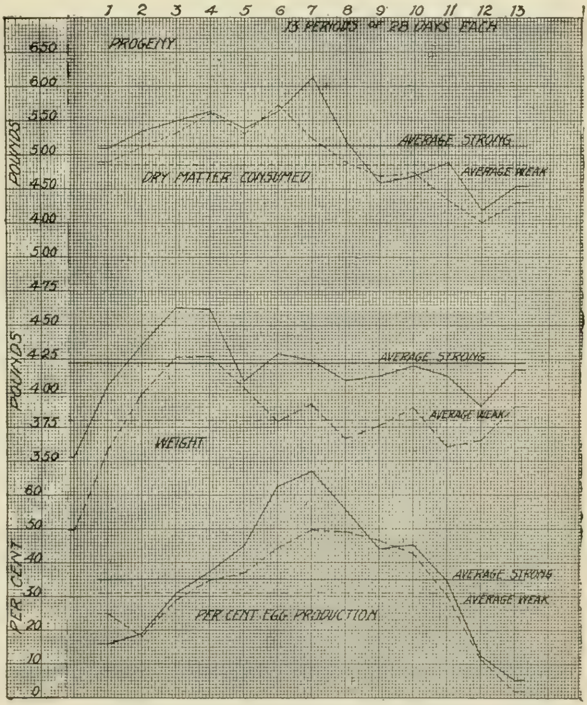

FIG. 165.—*The average dry matter consumed, the average weight of fowls, and the percentage of egg production, by periods of twenty-eight days each*

WEIGHT OF EGGS

In all comparison flocks the average weight of the eggs from the strong fowls was the greater. It is noticeable in Table 29 that there were fluctuations from period to period, and

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* Similar results are illustrated in Bulletin 258 of this station, Figs. 16 and 17.

TABLE 29. NUMBER OF EGGS FOR THE LAST SEVEN DAYS OF EACH PERIOD AND THEIR AVERAGE WEIGHTS IN GRAMS
(November 24, 1908, to November 22, 1909)

Period	Progeny from summer selected				Progeny from fall selected								True average			
	White Leghorns				White Leghorns				Barred Plymouth Rocks							
	Strong		Weak		Strong		Weak		Strong		Weak		Strong		Weak	
	Pen 20		Pen 22		Pen 11		Pen 13		Pen 12		Pen 14		20, 11, and 12		22, 13, and 14	
	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Average weight	Number of eggs	Weight	Number of eggs	Weight
1	45	50.7	74	51.0	11	47.8	9	49.5	13	47.6	6	46.3	23.0	49.7	29.7	50.5
2	63	52.0	70	52.2	12	53.5	17	52.0	27	50.9	13	48.9	34.0	51.9	33.3	51.7
3	64	52.5	77	55.5	31	51.3	18	48.3	19	52.3	7	43.7	38.0	52.1	34.0	53.4
4	110	54.3	111	54.6	23	51.4	23	50.1	32	50.5	9	48.0	55.0	53.2	47.7	53.5
5	121	55.8	122	55.0	19	52.2	29	49.1	36	51.5	24	48.7	58.7	54.5	58.3	53.2
6	123	60.2	97	52.8	24	51.6	31	51.2	53	53.6	33	50.2	66.7	57.4	53.7	52.0
7	136	55.1	111	54.1	24	50.7	34	51.2	59	53.7	44	47.8	73.0	54.2	63.0	52.1
8	96	54.1	102	54.1	18	49.8	32	50.3	35	52.4	48	48.0	49.7	53.2	60.7	51.8
9	94	55.7	110	55.9	18	52.7	19	52.2	29	53.8	44	47.4	47.0	54.9	57.6	53.3
10	92	60.1	79	53.7	19	50.9	28	52.7	38	52.2	32	47.0	49.6	56.9	46.3	52.0
11	26	57.0	22	56.9	11	52.7	14	52.0	44	53.2	16	53.3	27.0	54.4	17.3	54.5
12	5	63.8	......	......	......	......	2	61.0	20	60.9	......	......	8.3	61.5	.7	61.0
13	1	67.0	4	58.2	1	56.0	4	56.5	11	56.0	......	......	4.3	56.9	2.7	57.4
Total..	976	......	979	......	211	......	260	......	416	......	276	......	534.3	......	505.0	......
Av....	......	55.7	......	54.1	......	51.3	......	50.9	......	52.9	......	48.3	......	54.4	......	52.5

that in some of these instances the weaker fowls laid the heavier eggs. This variation in weight does not seem to be influenced particularly by an increase or a decrease in the number produced.

COST PER DOZEN EGGS PRODUCED

The cost per dozen eggs produced was lower in the strong pens except in the same weak flock (13) that laid a greater number than its corresponding strong flock. This cost, however, as illustrated in Table 30, is considerably higher than the cost of producing a dozen eggs the year previous by the parents of these pullets. This is due to the increased price of food rather than to increased consumption or decreased production.

TABLE 30. COST PER DOZEN EGGS PRODUCED
(November 24, 1908, to November 22, 1909)

	Progeny from summer selected		Progeny from fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	20	22	11	13	12	14	....	....	....	....
Parents' pen	78	79	76	75	21	23	....	....	....	....
Cost of food per dozen eggs	$0.111	$0.116	$0.133	$0.125	$0.163	$0.210	$0.134	$0.144	....	$0.010
Cost of food minus value gain in weight per dozen eggs	0.106	0.112	0.125	0.114	0.142	0.167	0.123	0.127	....	0.004

It is interesting to note that the parents of these pullets produced eggs during the same year at nearly as low a cost per dozen.

INCUBATION

It is noticeable in Table 31 that the eggs from the strong and weak pens varied indiscriminately in fertility and hatching power. In fact, the average percentage of chicks hatched from all the weak pens was greater than that from the strong ones. This was partially offset by the higher average fertility of the eggs, heavier weight of the eggs and chicks, and lower average mortality among the chicks from the strong flocks. These inconsistent results may be due to the lack of any selection after the original pens were mated up. No fowls were removed from the pens until they died. All the eggs laid during certain periods were incubated, and practically all the pullets matured were kept for further observations.

TABLE 31. INCUBATION REPORT

(November 24, 1908, to November 22, 1909)

	Progeny from summer selected		Progeny from fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	20	22	11	13	12	14	......	......	......	.....
Parents' pen	78	79	76	75	21	23	......	......	......	.....
Number of eggs set	273	263	155	178	268	123	232	188	44	.....
Percentage of fertile eggs	89.4	69.2	76.1	96.0	77.6	83.7	81.8	80.8	1.0	.....
Percentage of eggs hatched to fertile eggs	26.6	31.3	51.7	51.4	33.6	47.5	34.4	42.5	......	8.1
Percentage of eggs hatched to number set	23.8	21.7	39.3	49.4	26.1	39.8	28.1	34.4	......	6.3
Average weight of chicks hatched (pounds)	0.076	0.076	0.077	0.075	0.082	0.077	0.078	0.076	0.002	.....
Average weight of eggs set (pounds)	0.120	0.122	0.112	0.111	0.115	0.107	0.116	0.115	0.001	.....

CHICK RECORD

In contrast with the results of incubation, Table 32 shows the chickens from the strong flocks to be healthier and stronger in all of the experiments. They were also uniformly heavier at the time of hatching and when the eggs were set, except in experiment I.

The percentage of males and females did not vary greatly in the different pens. There was a consistently larger number of males than females, as shown in Table 32:

TABLE 32. CHICK RECORD

(November 24, 1908, to November 22, 1909)

	Progeny from summer selected		Progeny from fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	20	22	11	13	12	14	......	......	......	......
Parents' pen	78	79	76	75	21	23	......	......	......	......
Number of chicks living at the end of six weeks	49	31	37	49	54	33	47	38	9	......
Percentage mortality up to six weeks of age	22.2	39.2	41.2	42.3	20.3	31.2	27.7	38.6	......	10.9
Percentage males	12.7	25.4	25.4	24.7	11.6	20.8	15.4	23.9	......	8.5
Percentage females	11.1	13.7	15.9	17.6	8.7	4.2	12.9	13.0	......	0.1
Percentage sex not recorded	76.2	60.9	58.7	57.7	79.7	75.0	71.7	63.1	8.6	......
Average weight of pullets at maturity (pounds)	......	......	2.6	2.5	......	......	2.6	2.5	0.1	......

FINANCIAL STATEMENT

Consistency is again shown in the results set forth in Table 33 on the financial standing of the pens. The average value of the eggs produced and the balance of profit are greatly in favor of the strong flocks, showing that the selection of the parent stock has stamped its influence on the progeny of the first year, at least.

TABLE 33. FINANCIAL STATEMENT PER HEN

(November 24, 1908, to November 22, 1909)

	Progeny from summer selected		Progeny from fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	20	22	11	13	12	14	......	......	......	......
Parents' pen	78	79	76	75	21	23	......	......	......	......
Value of eggs	$3.55	$3.28	$2.97	$3.09	$3.21	$2.32	$3.38	$3.00	$0.38	......
Value of gain in weight	0.05	0.04	0.07	0.11	0.21	0.33	0.10	0.12	......	$0.02
Cost of food	1.30	1.23	1.31	1.28	1.69	1.58	1.41	1.32	0.09	......
Cost of loss of stock	0.08	0.01	0.33	0.11	0.11	0.23	0.12	0.08	0.04	......
Total income	3.60	3.32	3.04	3.20	3.42	2.65	3.48	3.12	0.36	......
Total outgo	1.38	1.24	1.64	1.39	1.80	1.81	1.53	1.40	0.13	......
Balance profit	2.22	2.08	1.40	1.81	1.62	0.84	1.95	1.72	0.23	......

PART IV

THE COMBINED TWO YEARS' WORK WITH THE ORIGINAL FLOCKS

The fourth part of this bulletin is concerned with the combined data of the first and the second year of work with the original pens. The data for either year alone do not give so substantial a basis on which to interpret results. A marked contrast is found existing between results with the same pen for the first and the second year. The combined work of the two years, therefore, eliminates this varying factor and provides a safer foundation on which to base conclusions. Only the more important parts of the work are thus summarized.

FOOD CONSUMPTION AND EGG PRODUCTION

It is shown in Table 34 and Fig. 166 that a dozen eggs were produced by the strong pens on 0.45 pound of food less than was required by the weak pens. In one individual comparison only, the Plymouth Rocks, the weak pen produced at a more economical rate.

TABLE 34. AMOUNT OF FOOD REQUIRED AND COST OF FOOD FOR ONE DOZEN EGGS
(True average for two years)

	Summer selected		Fall selected				True average	
	White Leghorns		White Leghorns		Barred Plymouth Rocks			
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78–78	79–79	76–76	75–75	21–21	23–23	....	......
Pounds of food required to produce 1 dozen eggs	8.15	8.69	8.45	9.42	10.64	10.40	9.05	9.50
Cost of food per dozen eggs	$0.121	$0.129	$0.126	$0.140	$0.157	$0.166	$0.133	$0.145

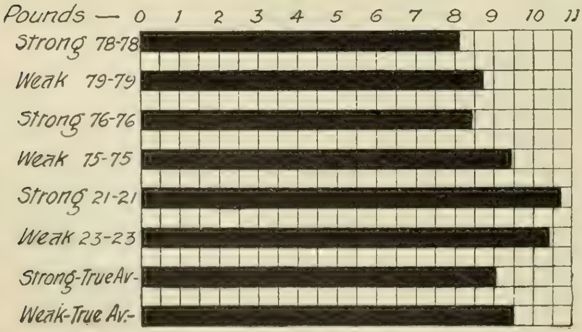

FIG. 166.—*The amount of food required to produce one dozen eggs. Average for two years*

The cost per dozen eggs, computed on the basis of the cost of food only, shows a similar relationship between the strong and weak pens. The average of all experiments shows that the strong fowls produced a dozen eggs at a cost 1.2 cent lower than did the weak ones.

The same relative comparison between the strong and weak flocks holds with the value of eggs produced and the balance profit, as shown in Table 35. In the two years the average strong fowl made a balance profit nearly fourteen cents more than that of the average weak fowl. An exception is noticeable here, also, in that the weak Barred Plymouth Rock flock netted a higher balance profit than the strong flock. This exceptional result is due to the unaccountably heavy mortality in the strong flock, since the total income from eggs and gain in flesh was greater in the strong than in the weak flock. This greater average profit of fourteen cents per hen for all the strong flocks is due to the marked superiority of the strong White Leghorn flocks over the weak ones. The fall-selected White Leghorn flocks show a difference amounting to 40.7 cents in favor of the strong.

TABLE 35. FINANCIAL STATEMENT PER HEN

(True average for two years)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pen	78–78	79–79	76–76	75–75	21–21	23–23	......	......	......	......
Value of eggs	$2.784	$2.796	$2.615	$2.174	$2.893	$2.787	$2.769	$2.609	$0.160	......
Value of gain in weight	0.030	0.047	0.012	0.014	0.014	0.013	0.060	0.069	....	$0.009
Cost of food	1.210	1.289	1.212	1.123	1.575	1.496	1.327	1.316	0.011	......
Cost of loss of stock	0.010	0.081	0.106	0.163	0.207	0.070	0.103	0.101	0.002	......
Total income	2.814	2.843	2.627	2.188	2.907	2.800	2.829	2.678	0.151	......
Total outgo	1.220	1.370	1.318	1.286	1.782	1.566	1.430	1.417	0.013	......
Balance profit	1.594	1.473	1.309	0.902	1.125	1.234	1.399	1.261	0.138	......

MORTALITY

In Fig. 167 it is shown that the mortality was high in all but one strong pen. These figures represent the total mortality for both years and not the average mortality. In one instance, a weak flock suffered less mortality than did the corresponding strong

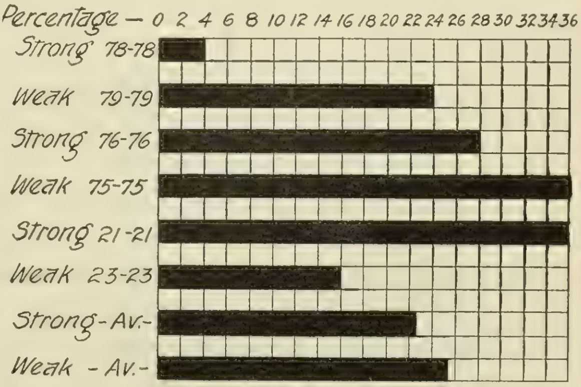

FIG. 167.—*The percentage of mortality. Total for two years*

flock — the weak Barred Plymouth Rock flock, the exception throughout all these tables. Even with this exception, the average of all strong flocks shows a mortality several per cent lower than that of the weak flocks.

INCUBATION

The two-year results in incubation given in Table 36 show a consistent and decided superiority of the strong over the weak flocks in each of the comparisons, as well as in the averages of the strong and weak flocks. The average fertility of the eggs from the strong flocks was 7.5 per cent greater, and the hatching power of the eggs 7.6 per cent greater, than from the weak flocks. The chicks from the strong pens were also heavier.

TABLE 36. INCUBATION REPORT
(True average for two years)

	Summer selected		Fall selected				True average		Difference
	White Leghorns		White Leghorns		Barred Plymouth Rocks				
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong
Pen	78–78	79–79	76–76	75–75	21–21	23–23	....	....	......
Number of eggs set	1,338	1,359	666	502	564	526	856	796	60
Percentage of fertile eggs	87.3	78.7	87.8	82.2	85.2	79.0	87.0	79.5	7.5
Percentage of eggs hatched to fertile eggs	63.0	61.9	52.3	43.5	44.2	34.3	56.1	51.9	4.2
Percentage of eggs hatched to number set	55.0	48.7	45.9	37.8	37.7	27.1	48.9	41.3	7.6
Average weight of chicks hatched (pounds)	0.079	0.079	0.083	0.082	0.080	0.075	0.080	0.079	0.001

PART V

A SUMMARY OF ALL FLOCKS

The fifth part of this bulletin gives a summary of the combined data of all the strong and weak pens in each experiment.

All these data show a consistent advantage of the strong pens over the weak. The few fluctuations among certain flocks did not affect the final superiority of the strong flocks. The differences, however, were somewhat less.

FOOD CONSUMPTION AND EGG PRODUCTION

The comparative number of pounds of food required to produce one dozen eggs and the cost of food per one dozen eggs produced are shown in Table 37 and in Figs. 168 and 169. In every comparison the strong pens produced eggs at a less consumption of food. The true average of all pens for all experiments shows that the strong flocks used 8.86 pounds of food to produce each dozen eggs, as compared with 9.35 pounds required by the weak flocks, a difference of 0.49 pound in favor of the strong flocks. The cost of producing eggs

TABLE 37. AMOUNT OF FOOD REQUIRED AND COST OF FOOD FOR ONE DOZEN EGGS (All experiments)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pens	78–78–20	79–79–22	76–76–11	75–75–13	21–21–12	23–23–14	....	......	....	......
Pounds of food required to produce 1 dozen eggs	7.82	8.19	8.51	9.13	10.58	11.12	8.86	9.35	....	0.49
Cost of food per dozen eggs	$0.117	$0.123	$0.128	$0.137	$0.155	$0.165	$0.132	$0.140	....	$0.008

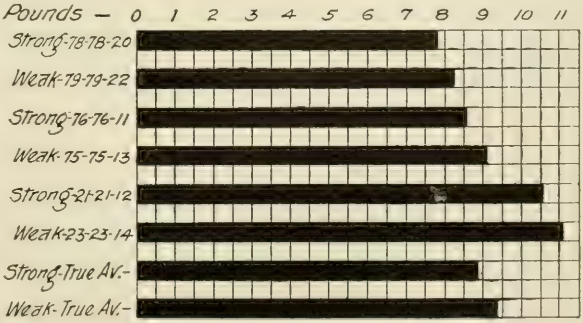

FIG. 168.—*The amount of food required to produce one dozen eggs. All experiments*

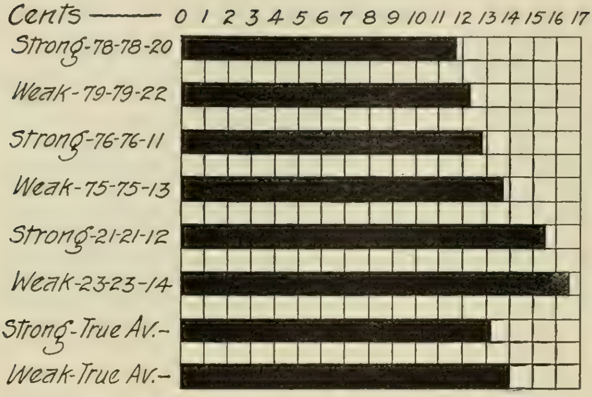

FIG. 169.—*The cost of food required to produce one dozen eggs. All experiments*

in the strong flocks was therefore slightly less—8 mills per dozen eggs—than in the weak flocks.

As shown in the financial statement, Table 38, the strong flocks produced enough more eggs than the weak to total 21 cents more per hen. Considering the value of the gain in weight, the cost of stock that died, and the cost of food, there remained a difference between the average strong and weak flocks of 14 cents per hen in favor of the strong flocks. Although the number of hens in the strong and weak flocks was the same at the start, the true total number* throughout the experiments was 186.56 for the strong and 177.38 for the weak. The total difference between the income from eggs and gain in weight, and the cost of food and lost stock, therefore, is $287.30 for the strong fowls less $248.33 for the weak fowls, or $38.97. These figures do not represent the actual balance profit, since the labor, incidentals, and interest on capital invested are not in-

TABLE 38. FINANCIAL STATEMENT PER HEN

(All experiments)

	Summer selected		Fall selected				True average		Difference	
	White Leghorns		White Leghorns		Barred Plymouth Rocks					
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak
Pens	78–78–20	79–79–22	76–76–11	75–75–13	21–21–12	23–23–14	......	......	......	......
Value of eggs	$3.07	$3.01	$2.67	$2.35	$2.98	$2.66	$2.93	$2.72	$0.21	......
Value of gain in weight	0.04	0.04	0.02	0.03	0.14	0.18	0.07	0.09	......	$0.02
Cost of food	1.24	1.26	1.23	1.15	1.60	1.51	1.35	1.32	0.03	......
Cost of loss of stock	0.04	0.05	0.14	0.15	0.18	0.10	0.11	0.09	0.02	......
Total income	3.11	3.05	2.69	2.38	3.12	2.84	3.00	2.81	0.19	......
Total outgo	1.28	1.31	1.37	1.30	1.78	1.61	1.46	1.41	0.05	......
Balance profit	1.83	1.74	1.32	1.08	1.34	1.23	1.54	1.40	0.14	......

---

* The true total number of hens is obtained by totaling the number of days each hen was in the experiment and dividing the sum by the total number of hen days in a year.

cluded. However, since those factors were the same for all comparison flocks, it can be said that the above figures do represent the comparative profit.

MORTALITY

The mortality was a very variable factor throughout the experiments. Although the total number of deaths was the same in the strong and weak flocks, it by no means represents the real difference in the vigor of the fowls. There were several deaths due to accident and others to viciousness. Pens 21, 21, and 12 (strong) were the only strong flocks where the mortality totaled more than in the corresponding weak flocks. To all appearances the Barred Plymouth Rocks in these strong flocks were much healthier and more vigorous than those in the comparison weak flocks. The comparative total percentage of mortality is shown in Fig. 170.

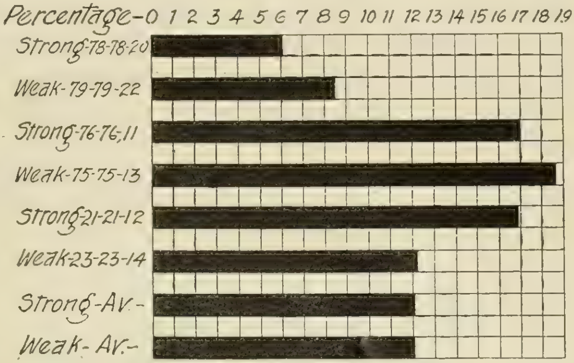

FIG. 170.—*The percentage of mortality. All experiments*

INCUBATION

In an experiment of this nature the hatching power of the eggs and the economical reproduction and replacement of the flocks usually is of

TABLE 39. INCUBATION REPORT

(All experiments)

	Summer selected		Fall selected				True average		Difference
	White Leghorns		White Leghorns		Barred Plymouth Rocks				
	Strong	Weak	Strong	Weak	Strong	Weak	Strong	Weak	Strong
Pens	78-78-20	79-79-22	76-76-11	75-75-13	21-21-12	23-23-14	....	....	. . .
Number of eggs set	1,611	1,622	821	680	832	649	1,088	984	104
Percentage of fertile eggs	87.7	77.2	85.6	85.8	82.8	79.9	85.9	79.7	6.2
Percentage of eggs hatched to fertile eggs	56.8	57.5	52.2	45.8	41.1	37.0	51.8	50.1	1.7
Percentage of eggs hatched to number set	49.8	44.4	44.7	39.4	34.0	29.6	44.5	40.0	4.5
Average weight of chicks hatched	0.079	0.079	0.082	0.079	0.081	0.076	0.081	0.079	0.002
Percentage of chickens living at the end of six weeks	64.6	61.2	62.1	65.3	76.6	72.8	66.4	64.1	2.3

equal importance to the economical production of eggs. Consequently the consistent advantage shown in Table 39 by the combined strong flocks, relative to fertility and hatching power of the eggs, should receive due consideration.

The incubation of several thousand eggs from both the strong and weak flocks is sufficient foundation on which to base fairly conclusive evidence. The difference in fertility alone shows an advantage of 6.2 per cent in favor of the strong flocks. The difference in percentage of eggs hatched to total number of eggs set favors the strong flocks by 4.5 per cent. In other words, for every 1,000 eggs set, 45 more chicks were hatched from the eggs of the strong flocks than from those of the weak flocks. On a basis of 10 cents value for each day-old chick, this would represent a value of $4.50 extra profit from each thousand eggs hatched from the strong flocks. In addition, the same table shows the chicks from the strong flocks to be slightly heavier, and consequently more fit to begin growth. This fact is illustrated in the table by the percentage of chickens alive at the end of six weeks.

It would seem from these composite tables, therefore, that the constitutionally strong fowls, even though the degree of superior strength is but small (as stated on pages 573 to 576), are capable of producing a larger number of eggs with greater economy, more fertile and hatchable eggs, and stronger progeny.

CONCLUSIONS

1. The selection of fowls for strong vitality, even though the selection be slight and exercised but once, increases the productive and the reproductive power of a flock.
2. One selection only, no matter how rigid, is not sufficient to keep a flock permanently superior.
3. The selection of mature pullets is of more value than that of partly grown chickens.
4. Selection at the beginning of the second year is of equal importance to that of the first year.

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THE COLLEGE OF AGRICULTURE

Department of Horticulture

SWEET PEA STUDIES—II

WINTER-FLOWERING SWEET PEAS

By ALVIN C. BEAL

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

The winter-flowering sweet pea, Canary

SWEET PEA STUDIES—II

WINTER-FLOWERING SWEET PEAS

ALVIN C. BEAL

Next in order to the waved section the most important type of sweet peas yet developed from the older garden forms is the winter-flowering class, which has reached its greatest perfection in the United States.

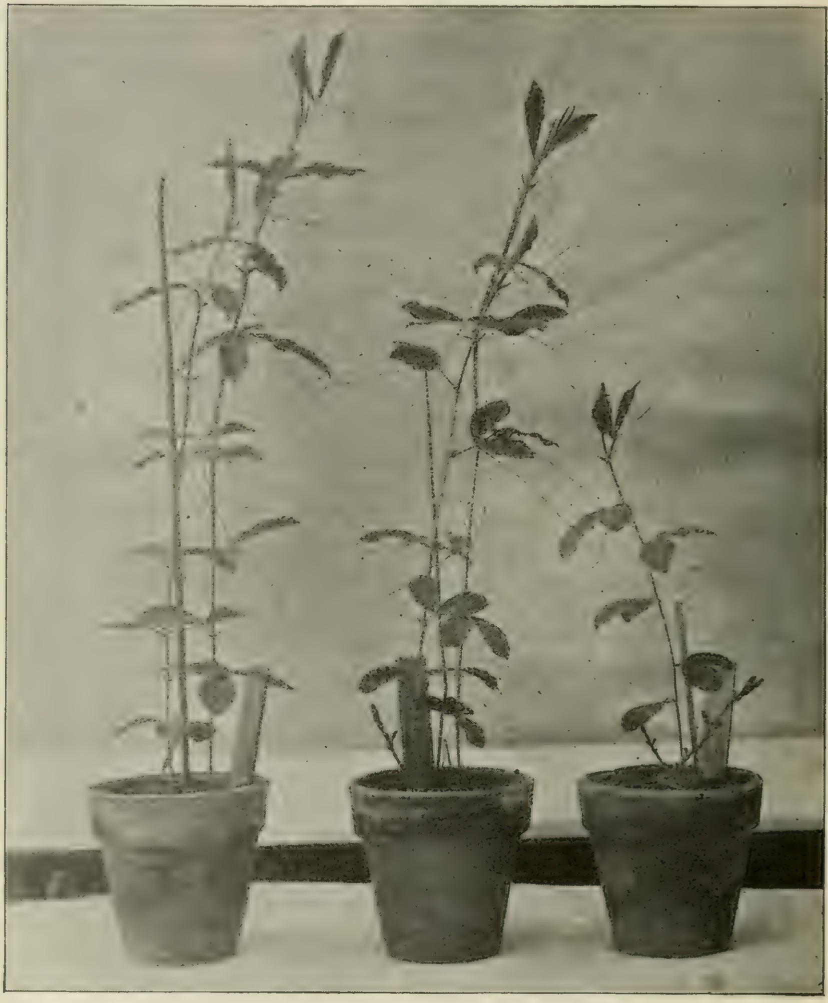
DISTINGUISHING CHARACTERS

The winter-flowering type is absolutely distinct in its habit of growth and its early-flowering character. Unlike the garden types, which apparently stand still for a time when only a few inches high while side shoots are developed, the winter-flowering peas grow rapidly until they attain a height of two to four feet; then they begin to flower freely, after which time side shoots are developed. In trials at this station the varieties of the winter-flowering type, planted September 24, came into flower between Thanksgiving and Christmas; while some varieties of the waved and the older types, planted at the same time, did not flower until the last week in April. Many varieties of the first-named type were flowering freely at the holidays, but the record would have been surpassed had it not been for the fact that during the month of November the region about Ithaca had not an entire day of sunshine and had only two partly sunny days. December was almost as dark and cloudy.

The winter-flowering peas make their greatest growth under glass. When planted in the spring in the open ground they make a very slender growth as compared with the garden type, and flower early in the season when a few inches high. However, they flower very profusely and continuously.

The garden type stools out well when planted under glass, but requires the entire winter for growth if planted in the fall. It is said by a practical grower that seed planted in January will flower as soon as that planted in August. This difference in habit of growth, manifesting itself very early, is of great value to the florist in enabling him to guard against loss from procuring the wrong seed.

The flowers of the winter-flowering type are generally of the open form of Blanche Ferry. Some of the English- and American-raised varieties of this type are hooded, and Anton C. Zvolanek is perfecting a waved-flower group. At this station it is thought that the open-flowered type is superior in substance in midwinter, and the flowers remain open. This appears, therefore, to be the commercial type. The perfection of this type will be along the line of increased size and of number of flowers on a stem.



Wallacea *Countess of Radnor*

FIG 171.—*Difference in growth of the winter-flowering and garden types*

The hooded varieties are often too much hooded and have, in the eyes of the buyer, a wilted appearance; or, even when they show their freshness, the flowers do not give the appearance of their real size, as is seen in Mrs. F. J. Dolansky.

FORCING SWEET PEAS

Fifteen years ago sweet peas were usually fairly plentiful in the markets of the large cities about the first of April, and sometimes flowers were seen as early as the last week in February. Among the varieties grown were Blanche Ferry, Lottie Eckford, Emily Henderson, and Katherine Tracy. The seeds were usually sown in August or September in pots and benched after chrysanthemums, or seeds were planted in carnation benches and the plants trained on the purlin supports of the greenhouse. William Scott advocated the above methods, especially the latter, as he asserted that the plants did not make much growth until the bright spring days when there was sufficient sunshine for both carnations and sweet peas.

Florists have been growing sweet peas under glass to a limited extent for a number of years. Soon after the introduction of Blanche Ferry, at least twenty years ago, this variety was tried under glass. The first record of sweet peas being grown under glass in any other than a very limited way is in 1897, when, Mr. Zvolanek states, he grew three houses of them, thus becoming undoubtedly the largest grower in the country at that time. In March of that year, sweet peas, white and pink, were reported as very plentiful in the New York market, selling at first at twenty-five cents for a bunch of twelve sprays.

Previous to the introduction of the Zvolanek varieties in 1906, besides the varieties above given, the following were grown: Emily Eckford, Golden Gleam, Countess of Radnor.

LEADING TYPES

Christmas-flowering group

This group of winter-flowering sweet peas was developed by Anton C. Zvolanek, now of Bound Brook, N. J., who doubtless supplied The Weekly Florists' Review with the following account of their origin, appearing in the issue of that periodical for April 13, 1899, page 495:

Sweet peas under glass

"The accompanying engraving is from a photograph taken January 6 last, of a house of sweet peas at the establishment of Mr. Ant. C. Zvolanek, West Hoboken, N. J. The boxes seen in the picture are 6 inches wide and 6 inches deep. The seed was sown in these boxes, out of doors, September 2, and the boxes taken inside the last week in October. The plants began to bloom November 20, and the first cut of 200 flowers was sent to market November 24. The house was 12 x 73 feet and built of sash containing 6x8-inch glass. The temperature given was 45 degrees at night. From this house Mr. Zvolanek cut 20,400 blooms during the month of December and 38,800 during January, the stems 14 inches long.

"The variety is one that originated with Mr. Zvolanek. Five years ago he noted among some Lottie Eckfords a plant that started flowering about two weeks earlier than the others and was dwarfer in habit. The following year he fertilized this with Blanche Ferry and the result was a decided improvement in color, size, stem, and habit. He named it Zvolanek's Christmas. He has five other houses of sweet peas, the seed having been sown outside in 4-inch pots early in September and the seedlings planted out in the solid beds inside in November and December in the same soil in which chrysanthemums had been growing. These seem to do as well as those in boxes, supplying a crop of flowers by Christmas."

The above account of the origin of this group is confirmed in a paper written by Mr. Zvolanek and published in Möller's "Deutsche Gartner-Zeitung," May 3, 1902. In that account he states that he discovered the original plants in January, 1892, among Lottie Eckfords that did not usually flower until March. The following is his account:

"On January 1, 1895, I was able to send the first ten dozen cut blooms to New York, where they occasioned great surprise. In 1899 I introduced this variety as Zvolanek's Christmas.

"Meanwhile I endeavored to secure other colors by crossing, in which I was also successful. In January, 1899, I exhibited four new seedlings before the New York Florists' Club, and these were in the colors pure white, lavender, malmaison-colored, and red; all of which were commended. Especially prominent is the pure white, which was registered with the Society of American Florists December 18, 1900, as Miss Florence E. Denzer and which will be sent out next August (1902). This excellent sort surpasses its mother, Zvolanek's Christmas, in the size of its flowers as well as in length of stem, producing over twenty per cent blooms with four flowers on very long stems."

There was found no record of the exhibit mentioned above, but the writer finds mentioned and illustrated in The American Florist for January 6, 1900, the following new and promising varieties originated by Mr. Zvolanek:

"No. 1 has been named Zvolanek's Christmas; No. 2 is a seedling from Emily Henderson; No. 3, variegated seedling; No. 4, sport from Zvolanek's Christmas; No. 5, seedling from Katherine Tracy."

The New York Florists' Club, on January 14, 1901, awarded honorable mention to A. C. Zvolanek for a pink variety named Christmas and for two white varieties, No. 6 and Miss Florence E. Denzer.

The parentage of the chief varieties of this group has been given by Mr. Zvolanek as follows:

Miss Florence E. Denzer — Christmas x Emily Henderson
Christmas Comtes — Improved Christmas x New Countess
Christmas Captain — Florence E. Denzer x Captain of the Blues
Miss Helen M. Gould — Florence E. Denzer x ———
Mrs. Alexander Wallace — Florence E. Denzer x Lady Grizel Hamilton
Mrs. Edie Wild — Christmas Pink x Salopian
Secretary William J. Stewart — Christmas Captain x Countess Spencer
Mrs. W. W. Smalley — Enchantress x Mrs. E. Wild
Mrs. William Sim — Christmas White x Mrs. E. Wild
Mrs. F. J. Dolansky — Seedling of Enchantress
Mrs. J. F. Hannan — Mrs. William Sim x Mrs. E. Wild
Miss Josie Reilly — Florence E. Denzer x Mrs. A. Wallace
Le Marquis — William J. Stewart x Gladys Unwin
Mrs. Charles H. Totty — Mrs. A. Wallace x blue unnamed seedling
Greenbrook — Mrs. George Lewis x unnamed seedling
Blue Bird — Walter Wright x Wallacea
Mrs. George Lewis — Watchung x Gladys Unwin
Mrs. Zvolanek — Helen Pierce x Christmas White
Governor Fort — Seedling of Mrs. William Sim x Spencer seedling

Mr. Zvolanek has probably originated over one hundred varieties, but of this number only the following thirty have been sent out:

1900, Christmas, or Christmas Pink.
1902, Miss Florence E. Denzer.
1905, Christmas Red and Christmas White.
1906, Mrs. E. Wild and New Christmas Flowering Hybrids, mostly blue, salmon, and lavender.
1907, Le Marquis, Mrs. A. Wallace, Mrs. William J. Stewart, Mrs. F. J. Dolansky, Jack Hunter, Christmas Captain, Mrs. Charles H. Totty, Miss Josie Reilly, and Christmas Meteor.
1908, Mrs. W. W. Smalley, Mrs. George Lewis, Greenbrook, Miss Helen M. Gould, and Marian Hannan (Mrs. J. F. Hannan).
1909, Wallacea, Governor Fort, Pink Beauty, Mrs. Zvolanek, Helen Keller, and Snow Queen.
1910, Blue Bird, Zvolanek's Blue, Zvolanek's Orange, Zvolanek's Pink.

Télemly group

The Télemly varieties of sweet peas have been offered in England for sowing under glass. So far as the writer can learn, they have not yet been offered or grown by the trade in this country.

This group was originated by the Reverend Edwyn Arkwright, in his garden at Télemly, on the hill of Mustapha near the city of Algiers, in Algeria, Africa. For a number of years our great American variety, Blanche Ferry, was grown. This variety has always been known as an early variety, and it flowered about the end of March in the locality mentioned.

The Reverend Mr. Arkwright, in an article in the Sweet Pea Annual for 1907, says:

"About seven years ago a sport showed itself in my garden as early as February and was promptly isolated from all others. The next year I had some plants flowering in January, and among them one red one, a cross apparently from Mars, on which a blossom or two had come out in May of the previous year. From these parents I have now ten or twelve of the usual colours, ranging from white to purple, and including duplicates, or shall I say imitations, of Honorable Mrs. E. Kenyon, Jeannie Gordon, Lady Grizel Hamilton, Mars, Black Knight, etc., which begin to flower about Christmas time and last for five months.

"That they form a distinct group is evident from the fact that Eckford's sweet peas, which I sow at the same time, *i. e.*, at the end of September, do not flower till May. Moreover, the leaf is considerably narrower than in Eckford's varieties and more pointed and the stem appears to have more woody fibre."

Engelmann group (*Lathyrus odoratus Praecox*)

Another group of winter-flowering sweet peas has been offered by C. Engelmann, of Saffron Walden, Essex, England. Mr. Engelmann says, in the Sweet Pea Annual for 1907:

"It is nearly four years since some plants of Captain of the Blues sported with me and gave winter-flowering varieties of quite distinct habit. Ordinarily stocks sown in autumn will not bloom under glass until the following April, but the newcomers commence to bloom from six to ten weeks after seed sowing, and continue to form branches and produce flowers all through the winter.

"I have now winter-flowering representatives of such varieties as Dorothy Eckford, Lady Grizel Hamilton, and Miss Wilmott, as well as a number of crosses between these and the ordinary type and Mont Blanc, so that almost all sweet pea colours are represented.

"In 1906 I sowed my winter-flowering varieties at the end of August and beginning of September, and the resulting plants commenced to flower in October and were splendidly in bloom at the end of November and early in December, and they should continue to flower until the ordinary sweet peas come into flower."

Blanche Ferry and its descendants

The following is quoted from an article by Will W. Tracy, in The American Florist, Vol. 13, April 2, 1898:

"Some forty years ago a woman in northern New York noticed and saved seed from a particularly bright-flowered plant of the Painted Lady. She planted them in her garden, and each succeeding year saved and planted seeds from what she thought were her best plants. She did not raise many, some years not more than a dozen plants and never more than could be grown in three square beds. She was the wife of a quarryman and her garden was always over limestone ledges where the soil, though fertile, was often not over a foot in depth, and gradually her plants became more compact and sturdy, until after some ten or twelve years she ceased to bush them, simply letting them support themselves. After she had raised them in this way for some twenty-five years a seedsman noticed their beauty, obtained about one hundred seeds, and from them has come the Blanche Ferry."

This variety was introduced by D. M. Ferry & Co. in 1889. In their catalog for that year it is shown by means of a colored plate.

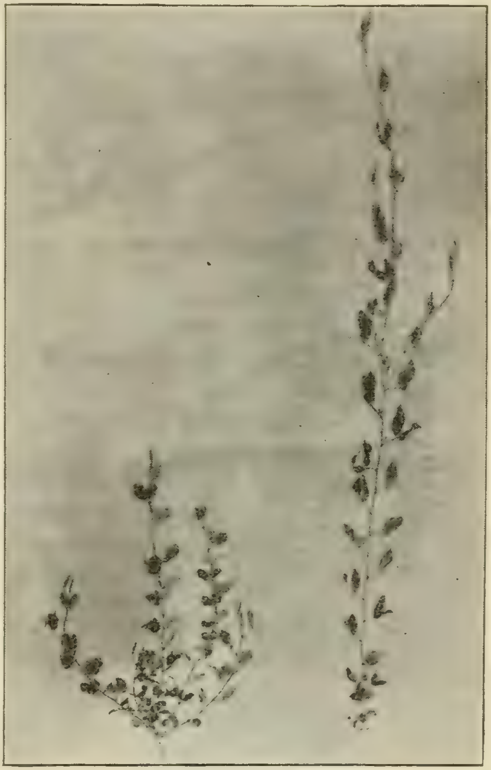


FIG. 172.—*Branching of the plants of the garden and winter-flowering types*

Peter Henderson & Co. introduced in 1893 the famous white variety, Emily Henderson, a sport of Blanche Ferry. In 1895 D. M. Ferry & Co. sent out Extra Early Blanche Ferry, which they produced in 1892.

Earliest of All was distributed in 1898 by Burpee. In his catalog he says that "it is not only the earliest to bloom in the open ground, but also the most desirable for forcing under glass for winter cut flowers. The dwarf habit of the plant (only two feet) renders it much more easily grown upon benches, admits of closer planting, and from seed sown in the latter part of August blooms may be cut for the holidays, while with the taller varieties no blooms could be cut before February or March." In 1902 the firm sent out an earlier strain of this variety under the name " Gould's Extreme Early Earliest of All."

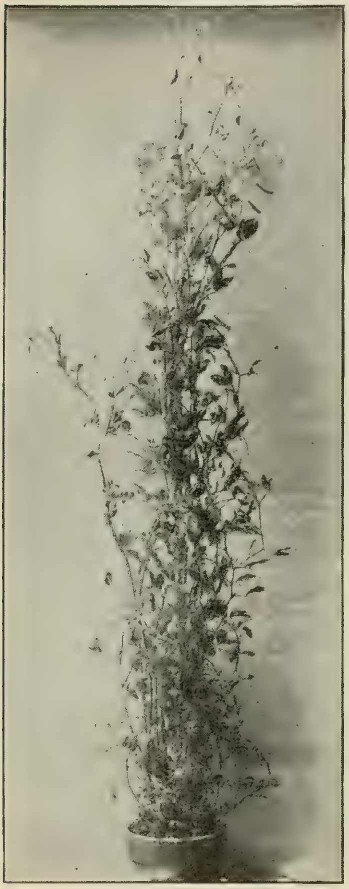


FIG. 173.—*Sweet peas grown in pots*

Mont Blanc was introduced by Ernest Benary, of Erfurt, Germany, in 1900. It is said that this variety came from Emily Henderson. Burpee, in his catalog for 1901, says that it is the exact counterpart of Earliest of All except in the color of the flowers, which are white.

Earliest Sunbeams appeared in 1904 and was described as a primrose Mont Blanc, with which it was identical except in color.

In 1904 Mr. Thomas Gould, of California, the originator of the strains of Earliest of All, found a white sport in a stock of the Reselected Earliest of All, which was identical with Earliest of All in every respect except color. Unlike Mont Blanc, it had a black seed. This variety, Earliest White, was introduced in 1906 by Burpee, who strongly recommended it for forcing.

Thus we had in 1906 a group of early-flowering varieties represented by Blanche Ferry, Extra Early Blanche Ferry, Earliest of All, Extreme Early Earliest of All, Mont Blanc, Earliest Sunbeams, and Earliest White, which were of distinct habit from the usual garden types and which were sometimes forced under glass. These varieties were all descendants of Blanche Ferry, from which they originated as seed sports either directly or indirectly. A further significant fact is that Blanche Ferry is a descendant of Painted Lady, which is the common name of the sweet pea described by Burmann in 1737 as a new species from Ceylon.

The known origin of the winter-flowering type of the Zvolanek and Télemly strains indicates their relation to Blanche Ferry, and this is confirmed by the fact that Watchung, Florence E. Denzer, and others are indistinguishable from varieties named above.

CULTURE UNDER GLASS

The house

Winter-flowering sweet peas grow six to ten or more feet high, and if they are to attain their full development a house with this amount of headroom is required. They also need all the light they can get, as the lighter the house, the more blooms there will be. Low or dark houses are not practicable.

Solid beds. — Sweet peas may be grown on benches, but solid beds are better since the plants require a deep, moist, cool soil. The roots should be given an opportunity to go down, by properly preparing the soil two or three feet in depth. With this depth of prepared soil it is imperative that the beds have good drainage, for oversaturation is detrimental to the young plants and any tendency to keep them in this state brings on sourness, which is fatal to sweet peas. Having the beds raised at least one foot above the walks will assist in keeping the soil uniformly sweet.

When planning to grow sweet peas under glass in solid beds, the house should be cleared as early as possible. Trench the soil two feet deep. If the beds have been manured annually, the bottom soil may be brought to the surface. In new houses, in case the beds are to be raised a foot, trench the soil eighteen to twenty-four inches deep if it is a good loam; if not, remove the soil and fill the beds with good soil. This gives an additional foot of loosened soil when the bed is full, but it is needed for additional drainage. In turning this original soil in a new bed, apply a heavy coat of good decomposed cow manure in the trench. Then spread on top a three-inch coat of manure and fill in with the prepared soil. In the old beds, put a three-inch layer of manure in the bottom of the trench and another about a foot below the top. The soil should remain thus until about the time for sowing; if a month or more intervenes, it is much better. At this time fork over the top layer one foot deep, which mixes the upper layer of manure with the surface soil.

Benches.— While good crops of sweet peas may be grown on benches, yet they require more care than when in beds. The sweet pea is frequently grown as a crop to succeed chrysanthemums, particularly by those florists who do not devote a great amount of space to pot plants. In order to have flowers for Christmas, the early chrysanthemums should be cleared from the house by October 20 and the space filled with good sweet pea plants transplanted from pots.

The seed

Only good, strong-germinating seed should be used, and the best for the purpose is the outdoor-grown stock of this type. If the grower raises his own seed for the earliest planting, that from outdoor fall-sown plants is preferable; otherwise it will always pay to purchase stock from the specialists who produce seed under California conditions. Seed procured near the end of the season from exhausted greenhouse-grown plants often germinates poorly or produces weak plants. Sometimes, even though the seedlings start off fairly well, they later exhibit constitutional weakness.

If the steam pipes are on the side walls, plant the first row of seeds five feet from them. If the rows run east and west, plant the others five feet apart; if the rows run north and south, space them three feet apart. Make the drills one or one and a half inch deep, and drop the seeds one to one and a half inch apart. Cover the depth of the drill, and keep the surface level.

Sowing

The winter-flowering varieties may be sown in the beds or benches where they are to stand, or they may be sown in pots. The former method gives the better results.* A day or two before planting, the beds should be thoroughly saturated with water; William Sim, the most extensive grower, advises a strong dose of liquid manure instead. As soon as the top has dried off so as to be in a good friable condition, plant the seed. The varieties with white seeds are best sown in sand; or, as Mr. Zvolanek advises, soak the seeds for ten hours in water, scatter in flats, and allow to remain for two days or until the seeds begin to swell. The seeds may then be sown in moderately dry soil in the same way as other varieties. The white-seeded varieties, more than any others, require careful attention in the watering.

Watering

If the soil has been saturated before planting, no more water should be applied for perhaps a week, or only when the soil is no longer moist three inches below the surface. When a thorough watering is not applied first, and the seed is sown and watered in, as a rule not enough water is given to saturate the soil very deep. The result is that the plant confines its root area to this shallow moist layer and does not root deeply. It therefore suffers from extremes, and any lack of moisture is followed by a check from which it never recovers. On the other hand, if the preparatory watering is given and water withheld until there is need of it, the roots strike downward into moist and cooler soil where they overcome, as far as possible, the effects of the hot days. The sweet pea must be kept growing steadily from the day the seed is sown. When water is needed, do not apply near the plants, but between the rows, where it should be given liberally. This treatment is especially important with

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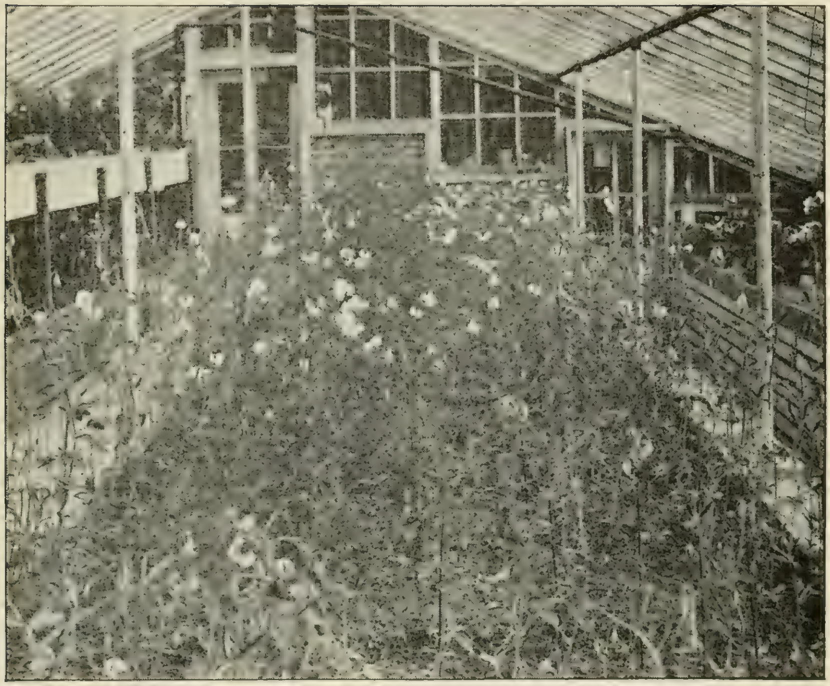
* One large grower sows the seed in flats or benches, in sand, transplanting the seedlings as soon as the upper side root is one half inch long. Two plants are placed in each two-and-a-half-inch pot. These are planted, four pots to one foot of row, in the greenhouse.



The house of winter-flowering sweet peas, February, 1910

the early plantings. One reason why water should not be applied too near the plants is that they are especially subject to damping off. This trouble becomes more prevalent in October and November, when there are more cloudy days, cool nights, and like conditions. Because of this, no soil should be heaped around the stem.

Time to plant

When a good crop of sweet peas is desired for Christmas, the seed should be sown the 20th of August. When sown September 1 the plants will flower in January; when sown September 15 the main crop will be in February; and when sown in October the crop will be ready in March. November sowings flower in the latter part of March; December sowings in April; January sowings in April and May; February sowings from May 1 on; and a March sowing in May or June. This gives the time when a reasonable crop can be expected, although flowers will be cut, especially with certain varieties, in a shorter interval than that given.

Some of the varieties in the tests at this station, sown October 20 and benched December 20, gave flowers during the last week in January, but not freely until about March. Some sown November 20 and benched December 20 began flowering in February and gave an abundance in March. Seed sown in beds September 24 this year gave flowers on Thanksgiving Day, although during the whole month of November there was not one clear day and there were only two partly clear days.

Supports

As soon as the peas are up, a support must be furnished. This may consist of string, wire and string, or wire netting. When string is used it is stretched lengthwise on each side of the row and fastened to stakes on the purlin posts. The wire-and-string support consists of wires stretched over the row, one near the ground and another eight to ten feet above it; between these, string is stretched lengthwise every ten inches, and perpendicular strings connect the top and bottom wires.

Wire netting is condemned by commercial growers. They maintain that the vines do not cling to it, so that just as much tying is needed; and, besides, more crooked stems occur than when the vines are trained on string. At this station, however, all the methods have been tried and the wire netting has been found preferable.

Temperature

Keep the temperature in the early stage as low as possible, giving full ventilation, day and night, as late as possible without freezing. The cooler the plants can be kept while growing, the stronger and healthier they will be. In this way the natural outdoor spring conditions are approximated.

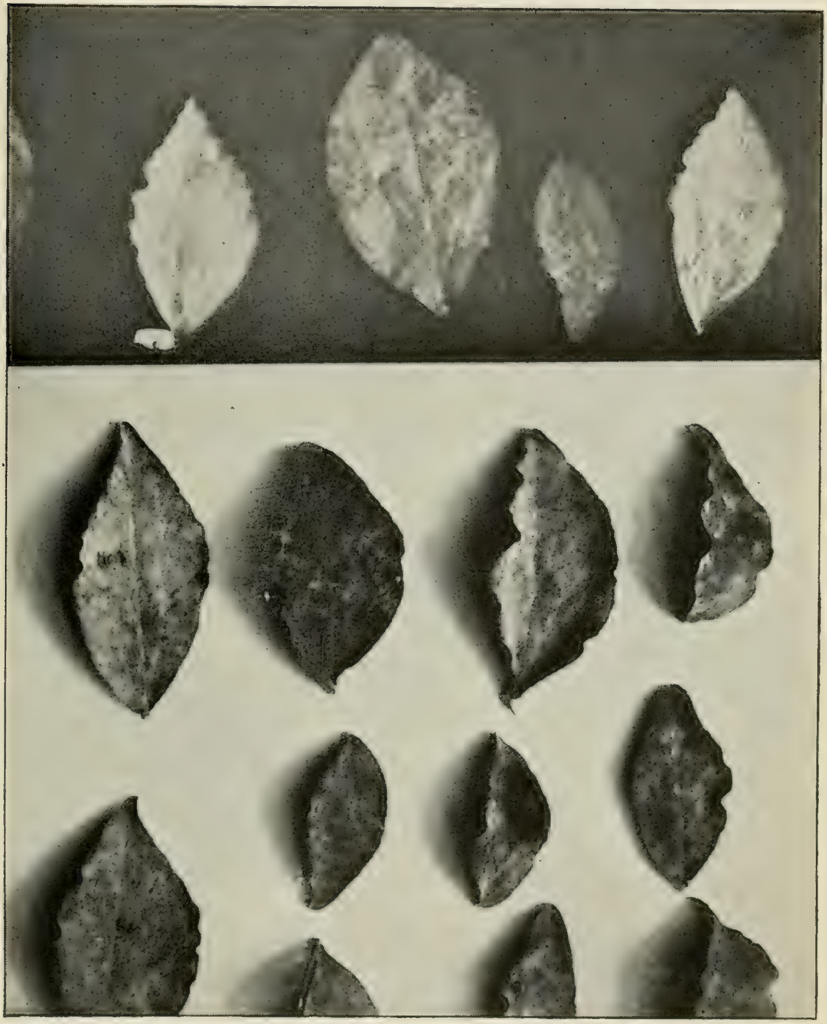
When the flower buds can be felt in the tips of the growing stems, the temperature should be raised 1° a night until 50° is attained, which is the proper temperature during December, January, and February. From about the end of February on, a night temperature of 48° is better. On bright days a rise of 10° or even 15° may be given. On cloudy days 55° is high enough, for higher temperatures promote soft, succulent growth that wilts when the sun comes out. Plenty of ventilation should be provided at every opportunity, as this, with careful regulation of temperature, causes a firm growth.

Insects

Sweet peas are especially subject to attack by the red spider, but unless the plants are too near heated pipes such attacks do not often occur except in the fall months. The careful use of water after the plants have attained a height of a few inches will eradicate this pest.

The common enemy of greenhouse plants, the green fly, attacks sweet peas from the time they appear above ground. These insects can soon destroy the young plants, as well as weaken the plants at any stage. Fumigation should be attended to carefully, the grower choosing cool nights or performing the work early in the morning; the chief object being to clear the plants thoroughly by regular and persistent fumigation so that they will not need fumigating when in bloom, as the odor is objectionable and injures the sale of the flowers. Tobacco also bleaches the flowers of some varieties. In the spring, when spraying plants with nicotine for green fly or for thrips, use this insecticide carefully as sweet peas are subject to injury from it. A nicotine preparation containing forty per cent of the constituent nicotine, used at the rate of two teaspoonfuls to each gallon of water, will kill the thrips that are hit by the spray.

Climbing cutworms and snails, if present in greenhouses, will destroy sweet peas. The former insects, which attack also carnations, violets, and chrysanthemums under glass, are combated by using compost that has not been covered by a rank growth of weeds and grass. When their work is noticed a search should be made for the worms under any mulch or lumps of earth on the bench, where they are coiled up during the day. They may also be picked from the plants at night while feeding. The use of poisoned baits is also recommended; among the best of these is the bran-arsenic mash, made by mixing one part white arsenic, one part sugar, and six parts bran, with sufficient water to form a mash. This may be placed among the plants. Snails can be controlled by the application of lime and soot to the surface of the beds or benches.



The sweet pea mildew

Diseases

The damping-off fungus has already been mentioned as causing the loss of young plants. Sometimes plants are seen with white- or yellow-streaked foliage. From experience at this station it appears that such a condition may follow the use of any soil that is not sweet. An instance occurred when a mold growing over the ashes of a bench entered the bottom of some pots of peas, causing the soil to become stale and musty. All the plants where this occurred showed streaked foliage later. The disease is undoubtedly physiological in its nature and is thought by practical growers to occur sometimes from the use of too much or too fresh manure on young plants.

The dropping of flower buds is often a cause of complaint from growers. The first flower buds frequently do not set on vigorous, thrifty plants. Usually this condition soon disappears, but sometimes it is necessary to keep the plants a little dry and to abstain from the use of fertilizers until the plants are blooming freely. The loss of the buds will follow a sudden fall in the temperature or will result from overwatering. Another cause is, growing the plants in too cool an atmosphere. Plants that are grown in the proper temperature, with careful attention to watering, ventilation, and feeding, do not fail to give an abundance of flowers.

Mildew sometimes attacks sweet peas during the autumn, unless the temperature and ventilation receive attention. It has been found at this station that mildew yields readily to applications of sulfur to the pipes, and to the use of flour of sulfur dusted on the infected leaves. As soon as the fires are started in the fall, some sulfur should be applied to the pipes as a preventive. This should be used judiciously, however, for an interesting case came under observation at this station during the past winter, of the danger of using sulfur too strong. An application had been made, and on a very cold night the pipe covered with the sulfur was turned on, the result being that every flower which was well advanced or open was scorched so that most of the flowers had to be thrown away. No injury to the plants occurred.

TESTS OF WINTER-FLOWERING SWEET PEAS AT CORNELL UNIVERSITY

The origin of the various groups of winter-flowering varieties of sweet peas has been traced above, and the varieties of the garden type formerly grown under glass have been noted.

All obtainable varieties of the winter-flowering type have been grown two seasons under glass, and also out of doors during the past summer.

From Anton C. Zvolanek, Bound Brook, N. J., were received original winter-flowering sweet pea seeds of the following thirty-one varieties:

Blue Bird, Christmas Captain, Christmas Pink, Enchantress, Florence E. Denzer, Governor Fort, Greenbrook, Jack Hunter, Le Marquis, Meteor, Miss Helen M. Gould, Miss Josie Reilly, Mrs. C. H. Totty, Mrs. F. J. Dolansky, Mrs. J. F. Hannan, Mrs. George Lewis, Mrs. A. Wallace, Mrs. E. Wild, Mrs. William Sim, Mrs. W. W. Smalley, Niger, Pink Beauty, Red Seedling, Variegated, Watchung, William J. Stewart, and Wallacea; in 1911, Zvolanek's Blue, Orange, Pink, and J. K. Allen.

From C. Engelmann, Saffron Walden, Essex, England, came the following six varieties of *Lathyrus odoratus* Praecox: White, Mauve, Deep Mauve, Carmine, Maroon, and Blue.

There were obtained from F. Fleetwood Paul, Botley, Hants, England, the following four varieties of "Paul's Improved Télemly Strain, or Christmas-Flowering Sweet Peas": Rose and Carmine, Mauve, Two Shades Pink, and White.

From the Reverend E. Arkwright, Télemly, Alger-Mustapha, Algeria, Africa, were received the following eighteen named varieties of Télemly sweet peas: Apple Blossom, Indigo Blue, Blue and Red, Cerise, Lavender and Pink, Lavender, Maroon, Mauve, Pale Pink, Pink, Pale Primrose, Purple, Purple and Maroon, Red Bicolor, Red Self, Red and White, Violet, and White.

Canary, Flamingo, Christmas White, Snowbird, and Mrs. A. C. Zvolanek, also seeds of Mont Blanc, Earliest Sunbeams, Earliest White, Earliest of All, Reselected Earliest of All, Emily Henderson, and Blanche Ferry, were received from A. T. Boddington, New York. The same firm forwarded packets of their stock of Florence E. Denzer, Mrs. W. W. Smalley, Mrs. A. Wallace, Mrs. William Sim, Mrs. E. Wild, Mrs. George Lewis, Christmas Pink, and Watchung, which were identical with the varieties of the same name in the Zvolanek collection.

The Bryson Ayres Company, Independence, Mo., sent the following varieties: Christmas Primrose, Mrs. A. Wallace, Ayres' Thanksgiving White, Christmas Blue, Mrs. C. H. Totty, Christmas Pink, Mrs. William Sim.

Altogether, seventy-three varieties, from five sources in America, Algeria, and England, have been tested at this station. This probably represents the largest collection of the forcing type ever brought together. In all these trials there has never been discovered the slightest reason for believing that any variety was a hybrid between some species of the vetch and *Lathyrus odoratus*. Side by side with the varieties of winter-flowering sweet peas the following species of vetch have been grown and studied at all stages of development: *Vicia sativa, V. villosa, V. gerardii, and V. fulgens.*

The winter-flowering *Lathyrus odoratus* Praecox and the Télemly strains all have the same habit of growth and early-flowering propensity, with the exception of Paul's Télemly Mauve, which is distinct from Arkwright's Télemly Mauve and which belongs to the outdoor type since it exhibits similar characteristics of bushy growth and is late-flowering. This variety, planted at the same time as the other varieties from Mr. Paul, produced flowers eight to nine weeks later; the second year it gave flowers seventeen to eighteen weeks later.

The Télemly varieties from Arkwright show by the form of their flowers that they have been derived from Blanche Ferry. The latter, when sown in August, does not flower much in winter, although it has much the same character of growth.

The varieties Florence E. Denzer and Mont Blanc, also Earliest White, Watchung, and Snowbird, and Christmas Pink, Earliest of All, Reselected Earliest of All, and Blanche Ferry, have flowers that are identical and the three last named come into bloom at the same time. The open-flowered varieties from Zvolanek and Boddington are earlier than the hooded varieties and are also less vigorous growers.

NUMBER OF DAYS REQUIRED TO BRING INTO BLOOM

Variety	Planted in pots October 22 (1909–1910)	Planted in open ground (1910)	Planted in beds September 24 (1910–1911)
Earliest White	71	68	60
Earliest of All	71	68	63
Watchung	71	68	63
Snowbird	71	68	66
Reselected Earliest of All	....	68	66
Blanche Ferry	....	68	66
Earliest Sunbeams	96	74	81
Two Shades Pink	92	....	85
Blue Bird	99	74	86
Greenbrook	104	74	87
Christmas Pink	99	74	87
Mont Blanc	99	74	88
Canary	112	76	88
Télemly Pale Primrose	93	....	88
Christmas Captain	105	75	88
Variegated	97	75	88
William J. Stewart	101	76	88
Télemly Apple Blossom	93	....	89
Télemly Maroon	95	....	90
Le Marquis	101	76	90
Christmas Meteor	101	76	90
Mrs. Zvolanek	....	....	90
Télemly Pink	95	....	93
Mrs. J. F. Hannan	97	79	93
Helen M. Gould	98	74	93
Télemly Indigo Blue	91	....	93

NUMBER OF DAYS REQUIRED TO BRING INTO BLOOM—(*Continued*)

Variety	Planted in pots October 22 (1909–1910)	Planted in open ground (1910)	Planted in beds September 24 (1910–1911)
Télemly Blue and Red	91	....	93
Christmas Enchantress	97	77	94
Mrs. C. H. Totty	106	76	94
Mrs. A. Wallace	106	77	94
Paul's Rose and Carmine	104	....	94
Christmas White	99	....	94
Wallacea	101	77	94
Flamingo	95	74	95
Arkwright's Télemly White	94	....	95
Télemly Purple	93	....	95
Florence E. Denzer	105	74	96
Niger	104	78	95
Télemly Red and White	92	....	96
Télemly Pale Pink	92	....	96
Pink Beauty	101	74	96
Red Seedling	103	74	96
Télemly Violet	98	....	98
Télemly Cerise	98	....	102
Jack Hunter	97	74	101
Miss Josie Reilly	99	79	101
Praecox White	105	....	101
Mrs. F. J. Dolansky	101	77	102
Mrs. William Sim	103	76	102
Mrs. W. W. Smalley	102	78	102
Télemly Red Self	98	....	102
Télemly Lavender and Pink	93	....	102
Télemly Mauve (Arkwright)	95	....	107
Télemly Lavender	101	....	107
Governor Fort	99	78	109
Praecox Carmine	111	....	110
Praecox Deep Mauve	109	....	110
Mrs. E. Wild	109	81	112
Praecox Mauve	107	....	124
Paul's Télemly Mauve	160	....	218
Mrs. George Lewis	99	76	96
Paul's Télemly White	94	....	102
The garden varieties tested 1910–1911			
Emily Henderson		81	202
Henry Eckford		88	214
King Edward VII		80	216
Countess Spencer		80	216
Helen Lewis		82	214
Primrose Spencer		84	216
White Spencer		84	212

The plants of the garden type started September 24 with the winter-flowering type produced their first blossoms during the last week in

April, while the latter were still blooming freely after having yielded cut blooms for nearly five months, and the extra early varieties for six months.

NUMBER OF DAYS COMING INTO BLOOM CLASSIFIED ACCORDING TO GROUP TO WHICH THE VARIETIES BELONG

Variety	1909–1910	1910–1911
Engelmann varieties — Lathyrus odoratus Praecox		
Praecox Blue	111	....
Praecox Carmine	111	110
Praecox Deep Mauve	109	110
Praecox Mauve	107	124
Praecox Maroon	109	....
Praecox White	105	101
Paul's Improved Télemly varieties		
Two Shades Pink	92	85
Rose and Carmine	104	94
Mauve	160	218
White	94	102
Arkwright's Télemly varieties		
Télemly White	94	95
Télemly Pale Primrose	93	88
Télemly Apple Blossom	93	89
Télemly Maroon	95	90
Télemly Pink	95	93
Télemly Indigo Blue	91	93
Télemly Blue and Red	91	93
Télemly Purple	93	95
Télemly Red and White	92	96
Télemly Pale Pink	92	96
Télemly Violet	98	98
Télemly Cerise	98	102
Télemly Lavender and Pink	93	102
Télemly Mauve	95	107
Télemly Lavender	101	107
Télemly Red Self	98	102
Télemly Red Bicolor	94	....
Télemly Purple and Maroon	98	....

DESCRIPTIONS OF VARIETIES

In the following descriptions of winter-flowering sweet peas and such other kinds as are used for forcing, the varieties are classified according to the form of the standard into two groups — open and hooded. Each group is subdivided into its leading colors by the marginal divisions. The white varieties are arranged in groups according to color of the seed — white seed and black seed. The year given is that in which the variety was introduced. The Répertoire de Couleurs was used as the standard chart in determining the colors of the flowers.

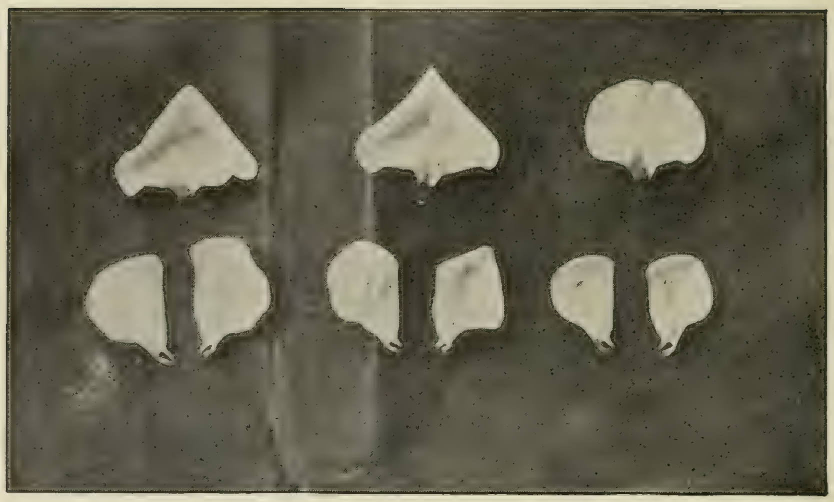


FIG. 174.—*Classification according to the form of the flower*

OPEN FORM

CHRISTMAS WHITE

White (White seed)

Originated by Zvolanek, 1905. *Donated by* Boddington.

Description in brief — Medium size, white, open-form, notched standard, dwarf growth.

Synonym — This is Florence E. Denzer.

FLORENCE E. DENZER

Originated by Zvolanek, 1902. *Donated by* Zvolanek, Boddington.

Description in brief — Medium size, pure white, open-form, notched standard, dwarf growth, medium early. Valuable for market.

Description in detail — Color snow-white 1–4 (2), the expanding flowers greenish white 1–2 (15). Open-form, flat, notched standard, long, narrow wings. Flowers two or three on stems of medium length, of good substance and fragrant. Plant dwarf, not over six feet. Seed white. Said to be a cross between Christmas Pink and Emily Henderson in 1895. Registered as Miss Florence E. Denzer, December 15, 1902.

Comparison — This variety is a month later than Watchung, Snowbird, and Earliest White. In the open it was a week later.

Synonym — Christmas White is the same variety.

MONT BLANC

Originated by Bernary, 1900. *Donated by* Boddington.

Description in brief — Medium size, pure white, open-form, notched standard, midseason, dwarf growth.

Comparison — Similar to Florence E. Denzer.

TÉLEMLY WHITE

Originated by ——————. *Donated by* Paul.

Description in brief — Medium size, pure white, notched standard, midseason variety of dwarf growth.

Remark — This variety has white seeds and germinated very poorly, giving two plants from ten seeds.

Comparison — Similar to Florence E. Denzer.

TÉLEMLY WHITE

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Large size, pure white, open-form, notched standard, midseason variety, of tall, vigorous growth.

Remark — This white contains a variety of hooded form similar to Dorothy Eckford.

Comparison — During both seasons this variety was distinctly larger than any other white variety.

EARLIEST WHITE

White (Black seed)

Originated by Gould. *Sent out by* Burpee, 1906. *Donated by* Boddington.

Description in brief — Medium size, pure white, notched standard, dwarf growth. Valuable because of its extreme earliness.

Description in detail — Fully open flower milk-white 2–3 (11); wings and standard have no trace of color except in the young bud. Open-form, flat, notched standard, wings long and broad. Flowers one to three on short medium stems, substance good, fragrant. An early and free bloomer. Plant dwarf, under six feet, begins to bloom when eighteen inches high. Leaflets dark green, narrow, and pointed. Seed large, round, and black.

Remark — Both seasons, under glass, this variety and its synonyms were three weeks earlier than any other variety, and in the open ground they were one week earlier than Mont Blanc.

Comparison — This variety is similar to Snowbird and Watchung.

SNOWBIRD

Originated by ——————. *Donated by* Boddington.

Description in brief — Medium size, pure white, open-form, notched standard, dwarf growth. Valuable for early forcing.

Comparison — Similar to Earliest White and Watchung.

WATCHUNG

Originated by Zvolanek, 1907. *Donated by* Zvolanek, Boddington.

Description in brief — Medium size, pure white, open-form, notched standard, dwarf growth. Valuable for early forcing.

Comparison — Very similar to Earliest White.

CANARY

Primrose

Originated by ——————. *Donated by* Boddington.

Description in brief — Medium size, primrose, open-form, notched standard, early variety.

Description in detail — Color of opening standard is cream-yellow 2 (30), fades to creamy white 2 (10); wings yellowish white 3 (13), fading to creamy white 1 (10). Flower open-form, with flat, notched standard, wings long, broad, and concealing the keel. Growth not tall, under six feet.

Comparison — Opens deeper yellow and not quite so large as Burpee's Earliest Sunbeams and Télemly Primrose. Standard erect and flat, while those of the last-named variety often reflex on the edges. Plant grew taller than other primrose varieties.

EARLIEST SUNBEAMS

Originated by Burpee, 1904. *Donated by* Boddington.

Description in brief — Medium size, primrose, open-form, notched standard, dwarf growth, early variety.

Description in detail — Color yellowish white 1–2 (13), black deeper shade, wings slightly lighter. Open-form, notched standard, long, broad wings. Flowers one to three on medium stems, substance good, moderately fragrant. Early and free bloomer. Plant not tall, under six feet. Leaflets dark green, narrow, and pointed. Seed white.

Comparison — This variety is similar to Télemly Pale Primrose, and was introduced prior to it.

TÉLEMLY PALE PRIMROSE

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size, open-form, primrose, notched standard, early variety.

Comparison — Similar to Earliest Sunbeams.

TÉLEMLY PINK

Pink

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Bright pink, medium size, open-form, notched standard, moderately vigorous grower, midseason.

Description in detail — Color of the standard as it opens is bright purple-rose 2–3 (150) or Rose Neyron red 1 (119), changing to pale lilac-rose 2 (130); wings mauve-rose 1 (153). Flower open-form, notched standard, with large, long, broad wings. Stems long and strong. Fragrant. Midseason. Plant a moderate grower.

Remark — One of the most beautiful pink varieties in the collection, but is not fixed.

ZVOLANEK'S PINK

Originated by Zvolanek, 1910. *Donated by* Zvolanek.

Description in brief — A large, open, soft pink flower.

Description in detail — Color of standard Rose Neyron red 1–2 (119); wings lilac-rose 1 (152) or paler. Flower large, open-form, and borne on stems of medium length and strength. Fragrance moderate. Good substance. Plant medium height, slender, but a very profuse bloomer.

MRS. W. W. SMALLEY

Cream pink

Originated by Zvolanek, 1908. *Donated by* Zvolanek, Boddington.

Description in brief — Medium size, soft pink, open-form, late variety.

Description in detail — Color of the standard, rosy flesh 1 (134); wings pale flesh 1 (136). Flower medium size, open-form standard sometimes with a faint notch, flat; wings long and narrow, concealing the keel. Season late. Plant a moderately vigorous grower, medium height.

Comparison — A Christmas or winter-flowering open-form Venus.

Registered with the Society of American Florists, March, 1906.

TÉLEMLY APPLE BLOSSOM

Bicolor

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size, open-form, flushed pink on light primrose standard, wings light primrose. An early variety.

Description in detail — Color milk-white 4 (11), standard flushed with pink 4 (7), in the center with milk-white edges. Wings milk-white. Variable in color and in size. Open-form, notched standard, wings large, long, and broad. Flowers on medium long stems, fragrant. Productive. Plant dwarf, under six feet, slender growth. Leaflets narrow and pointed.

Remark — Fully one half rogues, one with a red standard and pink wings, the other an inferior variety with purple standard and blue wings.

CHRISTMAS PINK

Originated by Zvolanek, 1899. *Donated by* Zvolanek, Boddington.

Description in brief — Medium size, red and white, open-form, early variety. Very valuable market variety grown under glass.

Description in detail — Under glass, color of standard is deep cerise 4 (123), wings are lilacy white 1 (7). Open-form standard notched, wings long and broad, concealing the keel. Flowers two to three on long, strong stems. Very productive.

Remark — This variety under glass was three weeks later than Earliest of All and other varieties, and in the open ground was one week later.

Comparison — Similar in color to Blanche Ferry, Earliest of All, and others, but much superior to these varieties in every respect except in earliness.

BLANCHE FERRY

Introduced by Ferry, 1889. *Donated by* Boddington.

Description in brief — Medium size, red and white, extra early, open-form, notched standard, short stems, plant a poor grower in midwinter.

Remarks — An old forcing variety, but superseded by Christmas Pink. Not productive from November to March, and stems too short.

EARLIEST OF ALL

Originated by Gould. *Sent out by* Burpee, 1898. *Donated by* Boddington.

Description in brief — Medium size, red and white, open-form, notched standard, extra early variety.

Remark — This variety was in every respect similar to Blanche Ferry and Reselected Earliest of All.

Comparison — Similar in color to Christmas Pink and Télemly Red and White, but much earlier. Not equal to those varieties for growing under glass in midwinter.

RESELECTED EARLIEST OF ALL

Introduced by Gould. *Sent out by* Burpee, 1902. *Donated by* Burpee.

Description in brief — Medium size, red and white, open-form, notched standard, short stems, extra early, plant a weak grower under glass.

Comparison — One year of trial under glass showed that this variety was not so vigorous as, and was no earlier than, Earliest of All. In the open ground this variety came into bloom on the same day as Blanche Ferry and Earliest of All.

TÉLEMLY RED AND WHITE

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size, open-form, red and white, notched standard, productive, midseason, very vigorous variety.

Description in detail — Flower open-form, flat, notched standard, wings long and broad, concealing the keel. Flowers two to three on very long, strong stems. Very productive. Plant tall, vigorous grower, over ten feet.

Comparison — Similar to Christmas Pink.

TÉLEMLY PALE PINK

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size, pink standard and primrose wings, open-form, strong grower.

Description in detail — Color of standard mauve rose 1 (153); wings lilacy white 3 (7). Flower open-form, notched standard, medium size, wings long and broad, concealing the keel. Flowers medium size, two and three on long, strong stems, fragrant. Midseason. Plant vigorous, tall, over eight feet. Leaflets narrow, pointed, and very dark green.

Comparison — Superior to Télemly Apple Blossom, as it has larger flowers, is a stronger grower, and is a pure stock. Is distinct from that variety, however.

CHRISTMAS METEOR

Crimson and Scarlet

Originated by Zvolanek, 1907. *Donated by* Zvolanek.

Description in brief — Medium size, red, open-form, notched standard, midseason, dwarf grower.

Description in detail — Color of standard crimson-red 1 (114), wings rosy magenta 1 (169) changing to magenta 2 (182). Flowers open-form, medium size, short stems. Standard notched at the top and with narrow base; wings long and broad, hooded, concealing the keel. Productive. Continuous bloomer. Midseason. Plant moderately tall grower, six feet. Under glass was a fixed variety.

Comparison — Distinct from Flamingo. Télemly Red Bicolor has a similar flower, but is later. Meteor is winter-flowering Ignea. In the open ground the flower blackens as does that variety, and the same rogue occurs in it.

Registered with the Society of American Florists, February, 1906.

TÉLEMLY RED SELF

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size, red, open-form, notched standard, late.

Comparison — Similar to Christmas Meteor, but in the experiments at this station it was later-flowering.

TÉLEMLY TWO SHADES PINK

Originated by ———. *Donated by* Paul.

Description — This variety was so badly mixed that it was absolutely impossible to determine the true variety. The best thing in it was a red similar to Meteor, and so the variety has been included here. There was no other with two shades of color except a few plants of Blue and Red Télemly, and one plant of Red and White Télemly. The majority of the plants produced flowers of a lilacy white or faint blush pink, but of very inferior form.

TÉLEMLY RED BICOLOR

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size, red bicolor, open-form, notched standard.

Description in detail — See Télemly Rose and Carmine.

TÉLEMLY ROSE AND CARMINE

Originated by ———. *Donated by* Paul.

Description in brief — Small to medium size, red, open-form, midseason variety.

Description in detail — Standard carmine lake 2 (121), and wings rosy magenta 2 (169). Flower open-form, notched standard, wings long and narrow, hooded. Variable in size, upper flowers on the spike are noticeably smaller. Stems long. Midseason.

Comparison — This is similar to Arkwright's Télemly Red Bicolor.

CHRISTMAS RED

Rose and Carmine

Originated by ———.

Remark — Mr. William Sim (in Horticulture, Vol. VII, No. 19, May 9, 1908, p. 628) says that this variety is identical with Flamingo.

FLAMINGO

Originated by ———. *Donated by* Boddington.

Description in brief — Medium size, red, open-form, midseason variety of short growth.

Description in detail — Color crimson-red 1 (114), fading to 3–4 (118); wings rosy magenta 1–2 (169), changing to magenta 4 (182). Flower open-form, notched in top of standard, the edges of which reflex; wings spreading, slightly hooded at tips. Flowers likely to run below medium size. Stems short. Little or no fragrance. A productive midseason variety. Plant of short growth, under six feet, with narrow, pointed leaflets. A pure stock.

TÉLEMLY CERISE

Cerise

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — A medium-sized, red variety.

Description in detail — Color is far from cerise, being in these experiments a solferino red 1 (157) on the standard, wings bishop's violet 1 (189). Flower open-form, notched standard and small size. Season late. Plant a moderate grower.

Purity — Badly mixed, with one half the plants Télemly Mauve, Télemly Pale Pink, and Télemly Pink.

TÉLEMLY LAVENDER

Lavender

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — A medium-sized, lavender variety.

Description in detail — Color of standard heliotrope 1 (188) and of wings heliotrope 1 (198). Flowers medium size. Standard flat, notched. Season medium to late. Not a vigorous variety here.

LAVENDER AND PINK

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size, lavender, open-form, late variety.

Description in detail — Color of the standard lilac-rose 1 (152) fading to lilacy white 1 (7), leaving the base lavender-blue; wings lavender-blue 1 (204), fading to almost white. Flowers medium size, open-form. Standard flat, notched. Wings long and broad. Season late. Plant a medium grower.

Purity — Contains Red and White, also Purple and Maroon.

TÉLEMLY MAUVE

Mauve

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size, mauve, open-form, late variety.

Description in detail — Color of the opening standard bright violet 4 (198), changing to heliotrope 1 (188); wings open bright violet 1 (198), change to Parma violet 1 (200). Flower open-form, faintly notched, flat standard; wings long and broad. Flowers medium size, on long stems. Fragrant. Profuse bloomer. Plant very vigorous grower, over eight feet.

Purity — Contains a hooded form, also an early-flowering, waved, blush pink.

Comparison — Can be called an open-form Mrs. Alexander Wallace. Differs from that variety in the open form, deeper violet in the opening flowers, and deeper blue of the wings.

TÉLEMLY MAROON

Maroon

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size, maroon, open-form, midseason, strong-growing variety.

Description in detail — The color is not found in the Répertoire de Couleurs; that of the standard is nearest 4 (172), but the wings are slightly purplish near 2 (185) and the keel is shaded bishop's violet 4 (189) on white. The effect is the color popularly called maroon. Flower open-form, notched standard, size medium. Stems long. Plant a vigorous grower.

Comparison — Distinct from Praecox Maroon.

MISS HELEN M. GOULD

Striped

Originated by Zvolanek, 1908. *Donated by* Zvolanek.

Description in brief — Medium size, red stripe, open-form, midseason, short grower.

Description in detail — Striped and flaked with lilacy white 1 (7) to pale light lilac 1 (187) on white ground. Wings creamy white 4 (10), fading to white. Flower open-form, notched standard, wings long and narrow. Flowers medium size on short to medium stems. Plant a short grower, under six feet.

Comparison — Of Earliest White type.

VARIEGATED

Originated by Zvolanek. *Donated by* Zvolanek.

Description in brief — Medium size, red stripe on white, open-form, early variety.

Description in detail — Standard heavily striped and flaked lilac-purple 4 (160) on white; wings fleshy white 1 (9). Flowers open-form, medium size, on short stems. Standard notched at the top, with narrow base. Plant a short grower, under six feet. Leaflets narrow, pointed, and very dark green.

Comparison — This is Mrs. Zvolanek, 1909.

MRS. ZVOLANEK

Originated by Zvolanek, 1909. *Donated by* Boddington.

Description in brief — Medium size, red striped on white, open-form, early variety.

Remark — This variety was grown in 1910–1911; catalogued as a Blue Variegated.

Comparison — This variety was received under the name "Variegated" in 1909.

CHRISTMAS CAPTAIN

Violet and Purple

Originated by Zvolanek, 1907. *Donated by* Zvolanek.

Description in brief — Above medium size, maroon-red standard and blue wings, open-form, early variety.

Description in detail — Color of standard plum-violet 2 (172) or vinous mauve 4 (184), with veins of darker color; wings light bluish violet 1 (202). Flower open-form, standard with notched top, reflexed edges, and narrow base, wings long and narrow, concealing the keel; size above medium, on medium long stems. Fragrant, very productive and early. Plant a moderate grower, seven feet. Leaflets narrow and pointed.

Purity — Stock is unfixed. In open ground it broke up into six varieties. Said to be impossible to fix.

TÉLEMLY BLUE AND RED

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size or slightly larger, maroon-red standard and blue wings, open-form, midseason variety.

Description in detail — Opening standard deep carmine-violet 3 (174), veins and midrib rich pansy-violet 4 (191). The standard changes to a deep purple 1 (184). The wings open violet-purple 1 (192), veins 4 (192), change to light bluish violet 1 (202). Flowers open-form, medium size or slightly larger. Standard slightly notched, flat; wings long, hooded, concealing the keel.

Comparison — Somewhat on the order of Christmas Captain, but has brighter standards and is a fixed strain.

TÉLEMLY PURPLE AND MAROON

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Medium size, maroon-red with dark blue wings, open-form, early variety.

Description in detail — Color of the standard is nearest to plum-violet 3 (172), but is brighter; wings near 4 (194), or bluer.

Comparison — The standard is similar in color to the standard of Blue and Red Télemly, but the wings are dark blue, instead of light blue as in that variety.

HOODED FORM

MRS GEORGE LEWIS

White (White seed)

Originated by Zvolanek, 1908. *Donated by* Zvolanek, Boddington.

Description in brief — Medium to large, pure white, slightly hooded, moderate grower.

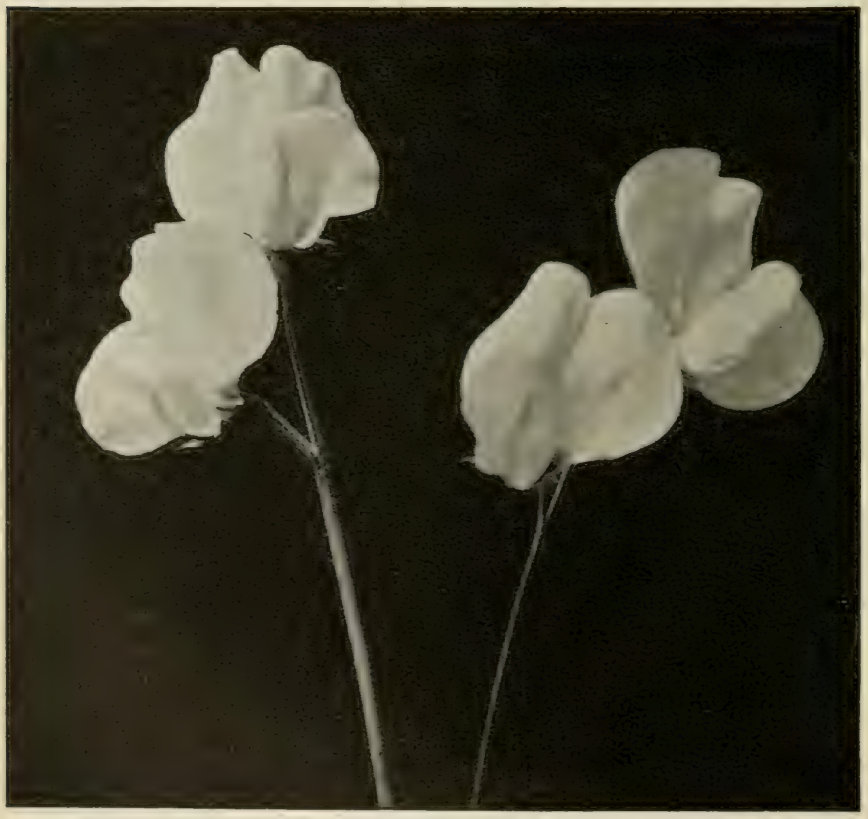


FIG. 175.—*The white-flowering sweet pea, Mrs. George Lewis*

Description in detail — Color snow-white 1 (2), slightly hooded form, some flowers approaching the waved form. Standard round, no notch, wings long and narrow. Flowers one to three on medium stems, substance under glass not equal to Watchung. Very mildly and sweetly perfumed. Plant of moderate growth. Leaflets narrow and pointed. Seeds white, a large number split, and one of the most difficult kinds to germinate. Must be carefully handled.

PRAECOX WHITE

Originated by Engelmann. *Donated by* Engelmann.

Description in brief — Medium-sized flower, late, white, extremely hooded, very long, strong stem, tall grower.

Description in detail — Flower extremely hooded, wings long and broad, concealing the keel. Moderately fragrant. Flowers three, medium size, on very long, strong stems. Profuse bloomer. Plant very vigorous grower, nine feet, with broad leaves. Seed white, but germinated well.

Comparison — A distinct variety.

JACK HUNTER

Primrose

Originated by Zvolanek, 1908. *Donated by* Zvolanek.

Description in brief — Medium size, dwarf growth, late. Color salmon-pink, hooded.

Description in detail — Color under glass, pale pink 4 (135) wings. Much hooded so that top of standard appears pointed, wings long and broad, concealing the keel. Flowers medium size, on long stems. Substance good. Free bloomer, and fragrant. Plant short, under six feet. Leaflets narrow, pointed, and very dark green in color. Seed black.

Comparison — Appears to be Christmas-flowering Stella Morse.

Registered with the Society of American Florists, February, 1906.

MRS. F. J. DOLANSKY

Pink

Originated by Zvolanek, 1907. *Donated by* Zvolanek.

Description in brief — Light pink self, extremely hooded, strong grower, late variety.

Description in detail — Color in midwinter light rose 1 (128), but later is mauve-rose 2 (153). Flower is extremely hooded, making apparent size smaller than the real. Stems of medium length. Plant tall grower, over seven feet, narrow, pointed leaflets. A true stock.

Comparison — This variety is superior to Christmas Enchantress. Is Christmas-flowering Prima Donna.

Registered with the Society of American Florists, April, 1906.

CHRISTMAS ENCHANTRESS

Originated by Zvolanek. *Donated by* Zvolanek.

Description in brief — Light pink self, extremely hooded type, dwarf growth, midseason.

Description in detail — Color mauve-rose 1 (153). Extremely hooded form, giving standard a pointed appearance and reducing flower below medium size. Shows too many side notches. Free bloomer, with medium stems, fragrant. Plant dwarf grower, five feet. Leaflets narrow and pointed.

Comparison — Inferior to Mrs. F. J. Dolansky. Is Christmas-flowering Blushing Beauty.

Registered with the Society of American Florists, February, 1906.

J. K. ALLEN

Originated by Zvolanek. *Donated by* Zvolanek.

Description in brief — A large pink flower.

Description in detail — Color of standard violet-rose 1–4 (154); wings lilac-white, suffused with lilac-rose 1–3 (7). Flower large, hooded, and borne on stems of medium length and strength. Fragrance moderate. Substance good. Plant medium height and moderately productive.

GOVERNOR FORT

Cream Pink

Originated by Zvolanek, 1909. *Donated by* Zvolanek.

Description in brief — Salmon-pink self, hooded late.

Description in detail — Medium-sized flowers on long stems, nicely hooded. Color pale lilac-rose 4 (130). Moderately fragrant, late. Plant is strong grower but of medium height, with very dark green leaves.

Comparison — Superior to Mrs. William Sim in color and form.

Registered with the Society of American Florists as Governor John Franklin Fort, May, 1908.

MRS. WILLIAM SIM

Originated by Zvolanek, 1907. *Donated by* Zvolanek.

Description in brief — Salmon-pink, hooded form, medium size, tall, vigorous grower. Late.

Description in detail — Standard bright rose 1 (128), wings crushed strawberry 1 (109) veined with Rose Neyron red 1 (119). Extremely hooded form, giving standard pointed appearance and reducing size. Stems long. Very vigorous, tall grower, over nine feet. Leaflets narrow and pointed. Stock true.

Comparison — Christmas-flowering Countess of Lathom.

Registered with the Society of American Florists, April, 1906.

RED SEEDLING

Crimson and Scarlet

Originated by Zvolanek. *Donated by* Zvolanek.

Description in brief — Red, extremely hooded flowers, on long stems. A vigorous grower. Midseason.

Description in detail — Color of standard brighter than amarante red, or dull dark crimson 3–4 (168); wings rosy magenta 2 (169), changing to magenta 1 (182). Flowers are of the extremely hooded form, appearing to be of only medium size due to pointed standard, which is not notched; wings large and spreading, showing the keel rather prominently. Midseason.

MRS. E. WILD

Originated by Zvolanek. *Donated by* Zvolanek.

Description in brief — Carmine-pink. Very late.

Description in detail — Standard nearly crimson-carmine 4 (159), wings on outside 1 (159) but inside much lighter. Wings very large, long, broad, and spreading, exposing the keel, and often extending beyond margin of the standard. Fragrant. Very late. Stems large and strong.

Registered with the Society of American Florists, February, 1906.

MRS. J. F. HANNAN

Rose and Carmine

Originated by Zvolanek, 1909. *Donated by* Zvolanek.

Description in brief — Medium size, carmine-netted, hooded variety.

Description in detail — Color of standard Tyrian rose 2 (155); wings violet rose 3 (154). In summer the color is solferino red 1 (157). Flowers on long, strong stems, fragrant, midseason, profuse bloomer. Plant a very strong, vigorous grower, making a dense, heavy growth, over nine feet. Leaflets narrow and pointed. Wings long, broad and concealing the keel.

Parentage — Seedling from Mrs. William Sim and Mrs. E. Wild.

Synonym — Marian Hannan.

Registered with the Society of American Florists, April 21, 1906.

MARIAN HANNAN

Originated by Zvolanek, 1908.

Synonym — Mrs. J. F. Hannan, 1909.

PINK BEAUTY

Originated by Zvolanek, 1909. *Donated by* Zvolanek.

Description in brief — "Dark pink self," hooded, midseason.

Description in detail — Color of standard Tyrian rose 2 (155), wings violet rose 3 (154). Standard hooded, round, broad base; wings long, broad, hooded, and concealing the keel. Flowers on very long, strong stems. Productive. Fragrant. Plant very strong grower, above eight feet. Leaflets narrow, pointed.

Comparison — This year it does not differ from Mrs. J. F. Hannan. In April, 1910, the latter variety contained more of a salmon tint.

PRAECOX CARMINE

Originated by Engelmann. *Donated by* Engelmann.

Description in brief — Carmine-netted, hooded, late variety.

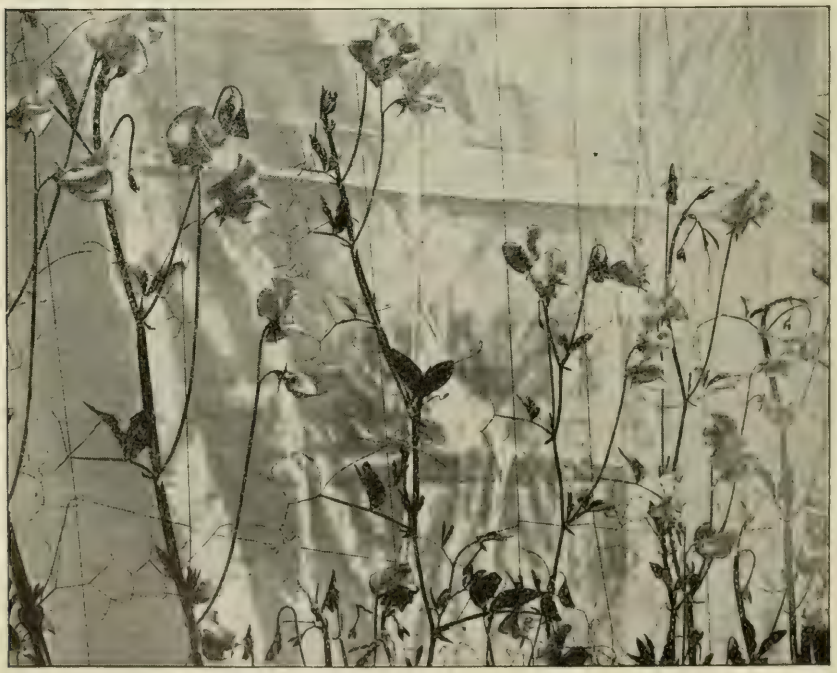


FIG. 176.—*Praecox Carmine*

Description in detail — Color of standard crimson-carmine, 3 (159) on the front and 4 (159) on the back. Sometimes a solid color, sometimes the spaces between the netting are lighter. Wings are almost pure mauve 2 (180). With age the flower changes, the standard losing its crimson, becoming magenta, while the wings become a sickly purple hue. The standard is hooded and the wings are large and broad. The flower is medium to large, on long stems. Fragrant. Productive. Plant tall, vigorous grower.

Comparison — Distinctly a deeper crimson than Mrs. Hannan or Pink Beauty.

CHRISTMAS COMTES

Lavender

Originated by Zvolanek.

Description in detail — When registered, described as "Clear lavender, average three flowers on a stem, plant five feet high, stems long. Improved Christmas and New Countess."

Comparison — "Lavender, similar to Countess of Radnor but much larger."— Florists' Exchange 22 (1906), p. 97.

Registered with the Society of American Florists, December, 1901.

TÉLEMLY MAUVE

Originated by ————. *Donated by* Paul.

Description in brief — A light lavender, hooded variety.

Description in detail — Color of opening standard is bishop's violet 1 (189), changing to lobelia blue 1 (205); wings open bright violet 4 (198), changing to ageratum blue 1 (201).

Comparison — Similar to Countess of Radnor.

Remark — This variety is not of the winter-flowering type, but is an outdoor variety which when sown in September or October does not flower until April.

PRAECOX MAUVE

Originated by Engelmann. *Donated by* Engelmann.

Description in brief — Lavender, hooded, very late.

Description in detail — Color of flower heliotrope 1 (188), changing to bright violet 2 (198). Flower medium size. Plant vigorous and productive.

Comparison — Distinct from Mrs. C. H. Totty because it has very much less violet in the opening flower and becomes a truer lavender.

MRS. CHARLES H. TOTTY

Originated by Zvolanek, 1907. *Donated by* Zvolanek.

Description in brief — Lavender, hooded, midseason.

Description in detail — Color of the opening standard is bright violet 1 (198), and wings ageratum blue 1 (201); changes to a light lavender-blue, much lighter than 1 (204), and wings fade to Parma violet 1 (200), with white edges. In midsummer it is more heliotrope as it opens. Flowers hooded, occasionally with side notches. Stems long and strong. Fragrant. Plant a tall, vigorous grower, over nine feet.

Comparison — A Christmas-flowering Lady Grisel Hamilton.

GREENBROOK

Mauve

Originated by Zvolanek, 1908. *Donated by* Zvolanek.

Description in brief — Lavender blush on white ground.

Description in detail — Color, standard shaded in center with bright violet 1 (198) on white (2) ground; wings are white (2). Flowers slightly hooded, medium-sized on long stems; fragrant. Productive, early.

Registered with the Society of American Florists, May, 1908.

PRAECOX DEEP MAUVE

Originated by Engelmann. *Donated by* Engelmann.

Description in brief — Deep mauve, extremely hooded, very late.

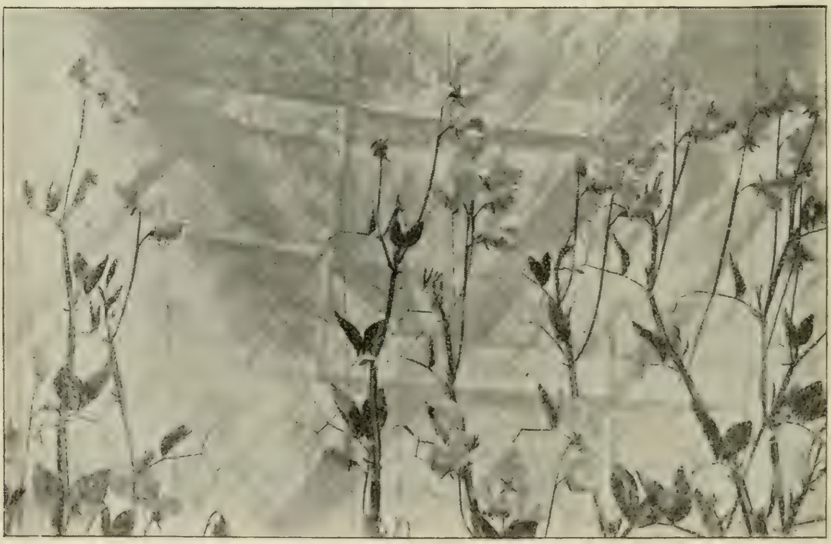


FIG. 177.—*Praecox Deep Mauve*

Description in detail — Color of standard is violet mauve 1 (195), changing to bright violet 1 (198) with edges bluish lilac 1 (183); wings open heliotrope 1–2 (188), becoming almost lobelia blue 1 (205). Flower extremely hooded, large-sized, on long stems. Plant tall, strong, vigorous grower, over nine feet; leaves broad and pointed.

Comparison — Distinct.

MISS JOSIE REILLY

Originated by Zvolanek, 1907. *Donated by* Zvolanek.

Description in brief — Lilac, with lavender wings.

Description in detail — Color of standard violet-rose 1–2 (154), fading to pale lilac-rose 1 (178) with paler edges; wings lighter than ageratum blue 1 (200). Flower of open form, trace of notch at the top of the standard, wings long, broad, and concealing the keel. Flowers medium-sized, on moderately long stems, late. Plant is a moderate grower, under six feet.

Registered with the Society of American Florists, April 21, 1906.

MRS. ALEXANDER WALLACE

Originated by Zvolanek, 1907. *Donated by* Zvolanek.

Description in brief — Lavender, hooded, medium-sized flower, and a vigorous grower. Midseason.

Description in detail — Standard opens bishop's violet 1 (189), changes to ageratum blue 1 (201). Wings open heliotrope 1 (188) and change to Parma violet 4 (200). Flower extremely hooded, making a pointed standard; wings hooded, concealing the keel. Fragrant. Free bloomer. Stems long. Midseason.

Comparison — Same color as Wallacea.

Registered with the Society of American Florists, February, 1906.

WALLACEA

Originated by Zvolanek, 1909. *Donated by* Zvolanek.

Description in brief — Lavender, midseason.

Comparison — This is a better strain of Mrs. Alexander Wallace.

PRAECOX MAROON

(*Lathyrus odoratus* Praecox)

Maroon

Originated by Engelmann. *Donated by* Engelmann.

Description in detail — Color is not found in Répertoire de Couleurs, but that of the standard is nearest 4 (172), while wings are more purplish, being nearest 4 (185); keel shaded bishop's violet 4 (189). Flowers of extremely hooded form, above medium size, on very long stems. Plant very vigorous grower, one of the tallest in the collection, over ten feet.

Comparison — Distinct from Télemly Maroon.
Remark — Contained Praecox Carmine as a rogue.

NIGER

Violet or Purple

Originated by Zvolanek. *Donated by* Zvolanek.

Description in brief — Deep, rich blue, hooded, medium size, and tall, vigorous grower. Midseason.

Description in detail — Color of standard rich pansy-violet 4 (191), wings bright violet-purple 3 (190), changing to violet-purple 1 (192). Standard without notch, wings short and broad. Flowers medium-sized, very slightly hooded, on very long stems. Productive. Plant tall, vigorous grower.

Comparison — Distinct from other blues.

Remark — Stock is mixed with Mrs. E. Wild.

PRAECOX BLUE

Originated by Engelmann. *Donated by* Engelmann.

Description in brief — A blue-self, medium-sized, hooded variety.

Description in detail — See William J. Stewart.

Comparison — Similar to William J. Stewart.

WILLIAM J. STEWART

Originated by Zvolanek, 1907. *Donated by* Zvolanek.

Description in brief — Blue self, hooded, medium size. Productive. Early.

Description in detail — Color of the standard as it opens is a purple-violet 2 (192), changing to bluish violet 4 (199); wings are brighter than 4 (190), changing to light bluish violet 1 (202). Standard sometimes notched on the sides, wings long, overlapping at tips, concealing the keel. Plant very vigorous, tall grower, ten feet.

Comparison — A Christmas-flowering Imperial Blue.

Registered with the Society of American Florists as Secretary William J. Stewart, March, 1906.

TÉLEMLY VIOLET

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Blue self, medium size. Early.

Description in detail — Color of standard purple-violet 3 (192), changing to bluish violet 4 (199); wings light bluish violet 4 (202), changing to 1 (202). Standard hooded.

Comparison — Similar to William J. Stewart.

TÉLEMLY PURPLE

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Purple, hooded, open-form, medium size, midseason.

Description in detail — Color of standard purple 4 (185); wings bright violet-purple 1 (190), changing to bluish violet. Flower with a round standard and long, broad wings. Fragrant. Stems long. Profuse bloomer. Plant tall, vigorous grower, over eight feet.

BLUE BIRD

Blue

Originated by Zvolanek, 1910. *Donated by* Zvolanek.

Description in brief — A blue self, hooded, large. Early.

Description in detail — Color of the standard light bluish violet 3 (202), with lilac lower edges; wings light bluish violet, without trace of lilac. Flower often opens with considerable violet. Extremely hooded, large-sized, on fairly long stems. Plant a moderate grower, over six feet.

Registered with the Society of American Florists, May, 1908.

LE MARQUIS

Originated by Zvolanek, 1907. *Donated by* Zvolanek.

Description in brief — Slightly hooded, indigo-blue color, medium size, strong grower. Midseason.

Description in detail — Color of standard violet purple 2 (192); wings light bluish violet 3 (202). Slightly hooded, without notch. Flower medium-sized, on long stems. Plant a tall, strong grower, eight feet.

Comparison — Télemly Indigo Blue is similar. Is Christmas-flowering Navy Blue.

Registered with the Society of American Florists, February, 1907.

TÉLEMLY INDIGO BLUE

Originated by Arkwright. *Donated by* Arkwright.

Description in brief — Slightly hooded, medium size, dark blue flower.

Description in detail — Color of standard violet-purple 1 (192) at the base, shading to 4 (192) at the edge; wings darker than light bluish violet 4 (202).

Comparison — Similar to Le Marquis.

ZVOLANEK'S BLUE

Originated by Zvolanek, 1910. *Donated by* Zvolanek.

Description in brief — A large, hooded, clear blue flower.

Description in detail — Color of standard light bluish violet 1-2 (202); wings lavender-blue 1 (204); both veined with darker color. Flower large and hooded. Stem of medium length and strength. Fragrance moderate. Keeping quality very good. Plant of medium height and slender growth, and inclined to be a shy bloomer.

ZVOLANEK'S ORANGE

Orange

Originated by Zvolanek, 1910.

Description in brief — A medium-sized salmon-pink flower.

Description in detail — Color of standard salmon-pink (1) 126; wings light lilac-purple 1 (160), flushed salmon-pink. The wings and standard veined with darker color. Flower medium-sized and hooded. Stem medium length and strength. Has little or no fragrance. A good keeper. Plant medium height, slender, and a moderate bloomer.

Comparison — " This can be represented as winter-flowering Miss Willmott."— Zvolanek's Catalog, 1910.

LIST OF ADDITIONAL VARIETIES

The following variety names are found in sweet pea lists or have been published:

ANGELINO

Originated by ————.

Description in brief —" Self pink."— Vaughan's Book for Florists, July, 1910.

Comparison — This variety as seen at Mr. Sim's place is the variety Earliest of All.

HELEN KELLER

Originated by Zvolanek, 1909.

Description in brief — " White and pink variegated."— Zvolanek's Catalog, 1909, p. 8.

MARION STANIFORD

Originated by Zvolanek.

Description in brief — " Standard maroon, wings blue. Seedling from Christmas Captain x No. 93. Registered with the Society of American Florists, April 21, 1906."

SNOW QUEEN

Originated by Zvolanek. *Introduced by* Zvolanek, 1909.

Description in brief — " Pure white. Entirely new type of sweet peas. The shape is between Countess Spencer and Unwin types; flowers just as freely as Florence E. Denzer or Mrs. George Lewis. Black-seeded."— Zvolanek's Catalog, 1909, p. 8.

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AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Horticulture

SWEET PEA STUDIES — III

CULTURE OF THE SWEET PEA

By ALVIN C. BEAL

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

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Waved varieties of sweet peas, August 23, 1910. A good display of bloom

PREFACE

This study was begun in the autumn of 1909. It has been carried on continuously under glass during two winters, and outdoors in the summer of 1910. A collection of the obtainable species of *Lathyrus*, as well as a very extensive collection of the varieties of sweet peas, was grown at Ithaca. In addition to the above the writer was enabled to study the exhibits of outdoor-grown sweet peas at the annual exhibition of the National Sweet Pea Society at New York in July, 1910, and of the winter-flowering varieties at Boston in March, 1911.

The investigation was begun with a view of studying the various species of *Lathyrus* for the purpose of monographing them, and particularly of determining their value as ornamental plants. The studies on sweet peas included the evolution of the flower, as well as the preparation of careful descriptions and the detection and elimination of synonyms among present-day varieties. The descriptions of the garden varieties will appear in a later publication; those of winter-flowering varieties are included in Bulletin 319 of this station.

The author wishes to extend his thanks and grateful acknowledgments to Professor John Craig, who has given great encouragement, kindly advice, and all possible facilities for carrying on the investigation; to the National Sweet Pea Society for their cooperation in the variety tests; to the United States Department of Agriculture for seeds of species of *Lathyrus*; and to the seedsmen of the United States and Great Britain who contributed seeds for the trials. Among the latter, mention should be made of the assistance rendered by Messrs. C. C. Morse & Co. in contributing a collection of seventy-two varieties, representing various types and old or obsolete varieties, for the study on the evolution of the sweet pea.

CONTENTS

Page
Part I. The genus *Lathyrus* 661
  Botany of the genus 661
    Artificial key to the species of *Lathyrus* 663
    Descriptions of the species 667
  History of the cultivated lathyrus 673
    Descriptions of cultivated species 674
Part II. The sweet pea in botany and in horticulture 678
  History of the sweet pea 678
    Botanical history 678
    British horticultural history 684
    American horticultural history 691
  Evolution 693
  Pollination 695
  Dwarf sweet peas 697
    Varieties of cupid sweet peas 698
    Unpopularity of the type 699
  Garden culture of the sweet pea 700
    The soil 700
    The seed 701
    Planting 702
    Supports 706
    Cultivation 709
    Summary 710
  Insects and diseases 710
    Insects 710
    Diseases 711
  Exhibiting sweet peas 711

SWEET PEA STUDIES — III

CULTURE OF THE SWEET PEA

ALVIN C. BEAL

PART I. THE GENUS LATHYRUS

BOTANY OF THE GENUS

The genus *Lathyrus* (a name used by Theophrastus for some leguminous plant) belongs to the important family Leguminosae, which embraces three suborders, eighteen tribes, and one hundred and twenty-seven genera of plants cultivated in North America. The suborder Papilioneae is distinguished from the suborder Mimoseae in having irregular or zygomorphic flowers, and from the suborder Caesalpineae in having papilionaceous flowers — that is, the standard outside the other petals, and enclosing them in the bud.

Among the most important genera that contain ornamental plants are *Thermopsis*, *Lupinus*, *Laburnum*, *Genista*, *Cytisus*, *Cladrastis*, *Hedysarum*, *Lespedeza*, *Lotus*, *Dolichos*, *Pueraria*, *Erythrina*, *Apios*, *Centrosema*, *Wisteria*, *Robinia*, *Clianthus*, *Swainsona*, *Caragana*, and *Glycyrrhiza*. Then there are the genera of economic importance, *Arachis*, *Onobrychis*, *Desmodium*, *Vicia*, *Pisum*, *Lens*, *Phaseolus*, *Vigna*, *Mucuna*, *Glycine*, *Trifolium*, *Medicago*, *Melilotus*, and *Indigofera*.

The plants of the tribe *Vicia*, which includes the genera *Abrus*, *Lens*, *Vicia*, *Pisum*, and *Lathyrus*, are typically climbing herbs, with evenly pinnate leaves, which raise themselves by means of tendrils at the tips of the petioles. The varieties of *Phaseolus*, the other tribe of typically climbing herbaceous plants, have twining stems and three leaflets.

Abrus differs from the other genera of this tribe in having woody stems, and nine stamens instead of ten. *Lens* (lentil) has flowers with the wings adherent to the keel. *Vicia* (vetch), *Pisum* (pea), and *Lathyrus* are closely allied and somewhat difficult to distinguish. *Vicia* is usually known by the sheath of the stamens being oblique at the mouth, and the style being slender and bearded at the apex or only around the upper part; *Pisum* and *Lathyrus* have the stamen sheath even at the mouth, but are distinct from each other in that in *Pisum* the calyx lobes are leafy and the style is flattened laterally and bearded down the inner edge, while in *Lathyrus* the style is flattened on the back and front and is bearded down one face.

The flowers of *Lathyrus* are solitary or racemose, on long, axillary peduncles. The calyx is oblique, campanulate, five-parted, the teeth nearly equal or the upper two shorter than the lower. The corolla consists of five parts. The upper, or odd, petal, known as the vexillum, or standard, is larger than the others and encloses them in the bud. There is a notch at the apex and ordinarily a short claw. The form is broadly obovate or roundish and the petal is usually turned backward or spreading. The colors are dark blue or purple, violet, rose, white, or yellow. The two lateral petals, or wings, are falcate, obovate, or oblong, oblique and exterior to the lower two, which are shorter, incurved, connivent, and more or less coherent along their anterior edge, forming the keel, or carina. The keel encloses the stamens and pistil.

The stamens are diadelphous (9 and 1), or monodelphous below. The style is curved, sometimes twisted, flattened, hairy along the inner side (next the free stamen); ovary sessile, or stalked with numerous ovules, becoming a one-celled pod. This is flat or terete, dehiscent, two-valved, continuous between seeds.

The seeds are globose or angular, with a hard, smooth testa. The radicle is curved inward. The cotyledons are accumbent.

The plants are herbaceous vines, rarely erect herbs, with pinnate, mostly tendril-bearing leaves. The old genus *Orobus*, which originally was created to include all the erect forms without tendrils, has since been included in the genus *Lathyrus* by Bentham and Hooker and by later botanists.

Species of *Lathyrus* are found in Europe, Asia, northern Africa, Sicily, and North and South America.

The genus is generally divided into two sections:

1. *Eulathyrus* (from *eu*, well, and *lathyrus*; genuine species). Vexillum toothless at the base. Leaves opposite or wanting. Petioles narrow-winged.
2. *Clymenum* (*clymenos*, clear). Vexillum furnished with a conical gibbosity on each side at the base. Lower petioles leafless; upper ones bearing two to six usually alternate leaflets. Petioles usually winged.

Horticulturally the species may be divided into perennial and annual species. The following classification of the species is based in part on the artificial key to the American species, published by Theodore G. White in the Bulletin of the Torrey Botanical Club, Vol. XXI, 1894:

Artificial key to the species of Lathyrus

- I. Habit climbing, leaves tendril-bearing.
  - A. *Eulathyrus.*
    - B. Annuals.
      - C. Petioles leafless.
        - *L. aphaca* L.
        - *L. Nissolia* L.
      - CC. Leaflets one pair.
        - D. Stems wingless.
          - *L. pusillus* Ell.
          - *L. subulatus* Lam.
          - *L. inconspicuus* L.
          - *L. sphaericus* Retz.
          - *L. micranthus* Gerard.
          - *L. angulatus* L.
          - *L. leptophyllus* Bieb.
          - *L. setifolius* L.
          - *L. hirtus* Lam.
        - DD. Stems winged.
          - *L. sativus* L.
          - *L. cicera* L.
          - *L. hirsutus* L.
          - *L. annuus* L.
          - *L. odoratus* L.
          - *L. Tingitanus* L.
      - CCC. Leaflets 2–3 pairs.
        - *L. clymenoides* DC.
        - *L. cirrhosus* DC.
        - *L. turgidus* Lam.
        - *L. purpureus* Presl.
        - *L. ciliatus* Guss.
    - BB. Perennials.
      - C. Leaflets one pair.
        - D. Stipules narrow.
          - E. Stems wingless.
            - *L. pratensis* L.
            - *L. tuberosus* L.
            - *L. sessilifolius* Tenore.
            - *L. roseus* Stev.
            - *L. tomentosus* Lam.
            - *L. sericeus* Lam.

I. Habit climbing, leaves tendril-bearing — (*Continued*).

- EE. Stems winged.
  - *L. sylvestris* L.
  - *L. pubescens* Hook.
  - *L. grandiflorus* Sims.
  - *L. rotundifolius* Willd.
  - *L. undulatus* Boiss.
- DD. Stipules broad.
  - E. Stems wingless.
    - *L. Magellanicus* Lam.
    - *L. nervosus* Lam.
  - EE. Stems winged.
    - *L. latifolius* L.
- CC. Leaflets more than one pair.
  - D. Stems winged.
    - *L. palustris* L.
    - *L. Watsoni* White.
    - *L. Jepsoni* Greene.
    - *L. heterophyllus* L.
  - DD. Stems wingless.
    - E. Plant glabrous.
      - F. Stipules large.
        - G. Leaflets 2–5 (mostly 3) pairs.
          - *L. ochroleucus* Hook.
          - *L. myrtifolius* Muhl.
          - *L. pauciflorus* Fernald.
          - *L. parviflorus* S. Watson.
          - *L. pisiformis* L.
          - *L. Bolanderii* S. Watson.
        - GG. Leaflets 5–7 pairs.
          - *L. sulphureus* Brew.
          - *L. Alefeldii* White.
          - *L. polyphyllus* Nutt.
          - *L. maritimus* Bigel.
          - *L. vestitus* Nutt.
      - FF. Stipules narrow.
        - *L. laetiflorus* Greene.
        - *L. splendens* Kellogg.
        - *L. decaphyllus* Pursh.
        - *L. violaceus* Greene.
        - *L. coriaceus* White.

I. Habit climbing, leaves tendril-bearing—(*Continued*).
    FF. Stipules narrow—(*Continued*).
        L. venosus Muhl.
        L. longipes White.
        L. graminifolius White.
        L. Macraei Hook.
    EE. Plant densely silky villous all over.
        L. litoralis.
  AA. *Clymenum.*
    L. diffusus.
    L. clymenum L.
    L. articulatus L.

II. Plant erect or nearly so, tendrils wanting or much reduced. (*Orobus.*)
  A. Peduncles 2–several-flowered.
    B. Flowers white or yellowish.
      L. montanus Bernh.
      L. Arizonicus Britton.
      L. Cusickii S. Watson.
      L. obovatus Torr.
      L. rigidus White.
    BB. Flowers purple.
      C. Leaflets 5–7 pairs.
        L. ornatus Nutt.
        L. Nuttallii S. Watson.
        L. niger Bernh.
        L. Oregonensis White.
        L. vernus Bernh.
      CC. Leaflets 1–2 pairs.
        L. bijugatus White.
  AA. Peduncles 1-flowered.
    L. Torreyi A. Gray.

Previous to White's monograph only two attempts had been made to enumerate the species of the genus. The first was by Alefield (Bonplandia, June, 1860), who placed all the American species in the genus *Orobus*; the second attempt was by Watson (Amer. Jour. Sci., Feb., 1876), who enumerated thirteen species.*

---

* Mention should be made of the more recent monographs on the genus *Lathyrus*, namely:

Über einige Orobus-Arten und ihre geographische Verbreitung. Series I Lutei. Ein Beitrag zur Systematik der Viceen. Von Dr. Karl Fritsch. Sitzber. K. Akad. Wiss. (Vienna), Math. Naturw. Kl. CIV Band (1895).

Über einige Lathyrus-Arten aus der Section Eulathyrus und ihre geographische Verbreitung. August Ginzberger. Sitzber. K. Akad. Wiss. (Vienna), Math. Naturw. Kl. CV Band (1896), pp. 281-353, plates and maps.

Some one hundred and thirty other species, which are considered good by the Index Kewensis but not included in the writer's classification, are as follows:

Acutus, Alberjilla, albus, Algeridus, Allardii, alpestris, altaicus, amoenus, aphyllus, Armeneus, asphodeloides, astrophia, aurantius, bijugus, blephari carpus, brachydon, brachypterus, Brownii, campestris, canescens, cassius, chloranthus, cicerella, cicerula, cinctus, coerulescens, colchicus, crassipe cryophilus, cyaneus, Davidii, debilis, dicirrhus, dielsianus, Dinklage diversifolius, Drummondii, dumetorum, ecirrhosus, elegans, Emodi, Eng manni, epetiolaris, erectus, Ewaldii, filiformis, fissu tescens, Go steinae, Gorgoni, gracilis, gracillimus, Graphiosa, helo ymita hygrophyllus, incurvus, intricatus, italicus, kilamana aetifol laevigatus, lanceolatus, lancifolius, Layardii, Ledebour nus, Lib linearifolius, lusitanicus, luteus, lycius, macrorrhizu magniflorus, sanus, marmoratus, Messerschmidtii, Mexicanus, microphyllus, mini mollis, Mulkak, multiceps, multiflorus, mutabilus, nervatus, neurol nitens, Numidicus, occidentalis, ochraceus, ovalifolius, pallescens, nonicus, parisiensis, Parreiszii, pentaphyllus, pisaster, platystylis, anthos, pseudo-aphaca, pterocaulos, puberulus, purpureo-coeruleus, qu marginatus, Sanbergii, Schmiperii, setiger, Shaffneri, sinensis, spathu spatulima, speciosus, spectabilis, stenobolus, stenophyllus, stipularis, str subandinus, subrotundus, Szowitsii, Tanakee, tetrapterus, trachyc trachyspermus, trichocalyx, Utahensis, variabilis, varius, venetus, vil vinealis, and Volckmanni.

The Encyclopedia of American Horticulture describes species in the American trade. These are: *odoratus, Tingitanu sylvestris, rotundifolius, undulatus, latifolius, Magellanicu maritimus, venosus, splendens, montanus, polymorphus, nig*

The writer has been unable to find *maritimus, undulatus, splendens, montanus, rotundifolius, polymorphus, grandiflorus*, and in the present-day lists.

Through the courtesy of Professor A. V. Piper, there has been re at this station the following reputed species from the United States ment of Agriculture: *L. cicera, L. sativus, L. sativus azureus, L. coccineus, L. sylvestris, L.* sp. (India), *L. Tingitanus, L. ochrus, L. sis, L. nervosus, L.* sp., and *L.* sp. (not named).

The following species and varieties were received from dealers in and plants:

Lathyrus latifolius, Henry A. Dreer, Philadelphia
Lathyrus latifolius albus, Henry A. Dreer

Lathyrus latifolius White Pearl, Henry A. Dreer
Lathyrus latifolius Delicata, Peter Henderson, New York
Lathyrus latifolius roseus, A. T. Boddington, New York
Lathyrus latifolius Pink Beauty, A. T. Boddington
Lathyrus latifolius albus, A. T. Boddington
Lathyrus latifolius White, J. M. Thorburn & Co., New York
athyrus latifolius Pink Beauty, J. M. Thorburn & Co.
athyrus latifolius splendens, R. & J. Farquhar, Boston
thyrus latifolius Giant White, R. & J. Farquhar
thyrus la erennial Pea, Red, James Vick's Sons, Rochester
nyrus rennial Pea, Rose, James Vick's Sons
hyrus rennial Pea, White, James Vick's Sons
hyrus sy M. Thorburn & Co.
yrus pubescens A. T. Boddington
yrus grandiflorus, Ellwanger & Barry, Rochester
yrus Lord Anson's Blue, A. T. Boddington
yrus Lord Anson's Blue, J. M. Thorburn & Co.
yrus Lord Anson's White, J. M. Thorburn & Co.
us niger, J. M. Thorburn & Co.
us lathyroides, J. M. Thorburn & Co.
us albus roseus, Henry A. Dreer
us superbus, Henry A. Dreer
us vernus, Henry A. Dreer
Orobus verr s, R. & J. Farquhar

the above, mostly annual species, flowered the first year.

Descriptions of the species

LATHYRUS SATIVUS L.

branching, smooth, winged, 2 feet high; leaflets linear-oblong; trifid; stipules semisagittate-ovate, ciliated, not so long as les; peduncles 1-flowered, longer than the petioles ($1\frac{1}{2}$–2 inches acteolate and articulate at the apex; calyx lobes lanceolate, is, almost three times length of tube; legumes ovate, short, broad, ly reticulated, winged on the back; seeds trigonal, smooth, trun- Native of Spain, France, and Italy. Flowers blue, sometimes te, $\frac{3}{4}$–1 inch in diameter. *L. sativus*, *L. sativus azureus*, and *L. sativus neus* were found at this station to be a mixture of white and blue

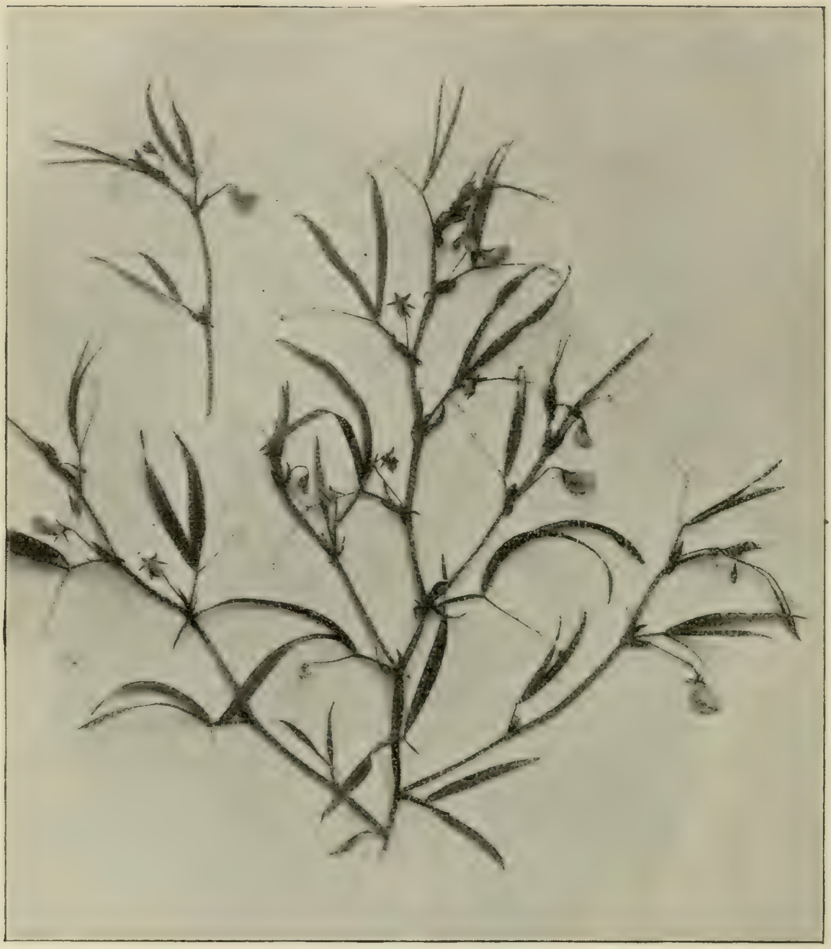

FIG. 178.—*Lathyrus sativus L.*

LATHYRUS CICERA L.

Stems smooth, 2 feet high, branching, winged; leaflets linear; tendrils branched; stipules semisagittate, narrow, much shorter than the petioles; peduncles 1–2-flowered, length of the leaves; bracteoles small; calyx segments lanceolate, nearly three times length of tube; legumes oblong, irregularly channeled on the back, not winged; seeds trigonal, truncate, smooth. Native of Spain. Flowers purple or red, variable.

LATHYRUS HIRSUTUS L.

Stems winged, 2 feet high; leaflets linear-lanceolate, 3-nerved; stipules semisagittate, linear, about equal the petiole in length; peduncles usually

2-flowered; calyx hairy, segments ovate-acuminate, length of tube; legumes oblong, hairy; seeds globular, warted. Native of southern Europe, in grainfields. Flowers with a bright crimson standard, pale blue wings and white keel.

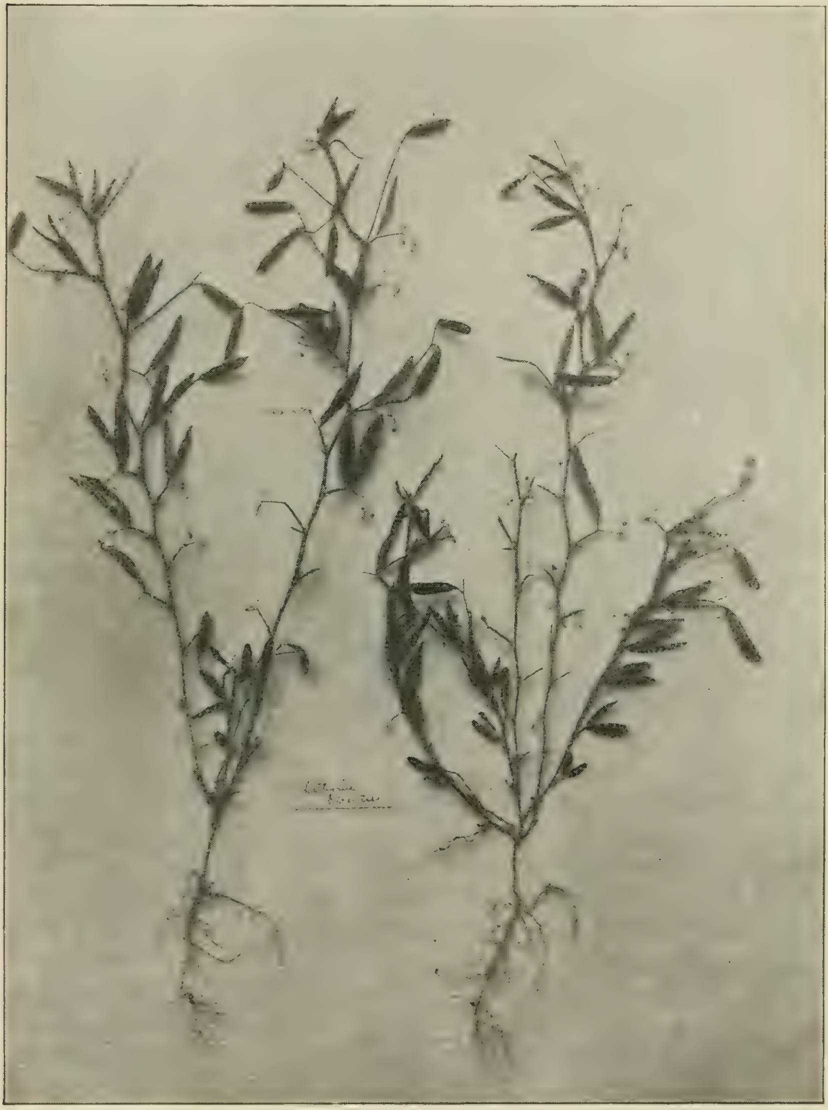

FIG. 179.—*Lathyrus hirsutus L.*

the petioles; peduncles 2-flowered, longer than the leaves; calyx teeth nearly equal; legumes linear, 4–5 inches long, much reticulated, compressed, sutures thick; seeds not angular. Native of the west Mediterranean region at Tangier. Flowers 1 inch long, dark red-purple: standard large, purple; wings and keel bright red.

LATHYRUS ODORATUS L.

Stems rough-hairy, winged oval or oblong, mucronate; stipules lanceolate, much shorter than the petioles; peduncle 2–4-flowered, much longer than the leaves; calyx teeth broad, longer than the tube; legumes compressed, linear, 1–3 inches, hairy; seeds round, sometimes angled, black, white, or mottled. Native of Sicily. Flowers large, showy, in shades of blue, red, yellow, and white. Standard large-expanded, hooded or wavy.

LATHYRUS OCHRUS DC.

Stems 4-angled, winged; petioles winged, lower ones leafless, upper ones with two leaflets; leaves glaucous; lower stipules wanting, upper ones ovate; peduncle 1-flowered; calyx teeth unequal, superior lobes shortest, length of tube; legumes with membranous wings, few-seeded; seeds globular. Native of southern Europe. Flowers pale yellow.

LATHYRUS SYLVESTRIS L.

Perennial

Stems straggling, 3–5 feet, stout, winged, glabrous, with creeping rootstocks; petioles winged, with one pair of linear-lanceolate leaflets; stipules narrow; peduncles 3–6-flowered, equaling the leaves; legumes compressed, reticulated, lanceolate, 2–3 inches long; seeds round, dotted. Native of Europe, in woods and hedges. Flower with one-half-inch-long standard: standard rose, with a green spot on the back; wings purple at the tips; keel greenish.

LATHYRUS PUBESCENS HOOK.

A soft, hairy, diffuse-branching herb; stems 3–5 feet high; stems, branches, and peduncles 4-angled, the angles forming stout ribs; petioles with one pair, rarely two pairs, of leaflets, sessile, 1–2½ inches long, oblong-lanceolate or elliptic-oblong, dark green, strongly ribbed beneath; stipules variable in size and form; peduncle longer than the leaves, many-flowered in lax or dense racemes; calyx tube broadly campanulate, upper teeth shorter; legumes linear, 2–2½ inches long, hairy, flat; seeds very small, ellipsoid. Native of South America, from Bolivia and southern Brazil to the Straits of Magellan. Flower variable in size, sometimes 1¼ inch broad, violet-blue: standard round, notched at the tip, margins recurved, violet-blue; wings broad, spreading, pale lilac dorsally, nearly white in front; keel petals falcately curved, with red tips.

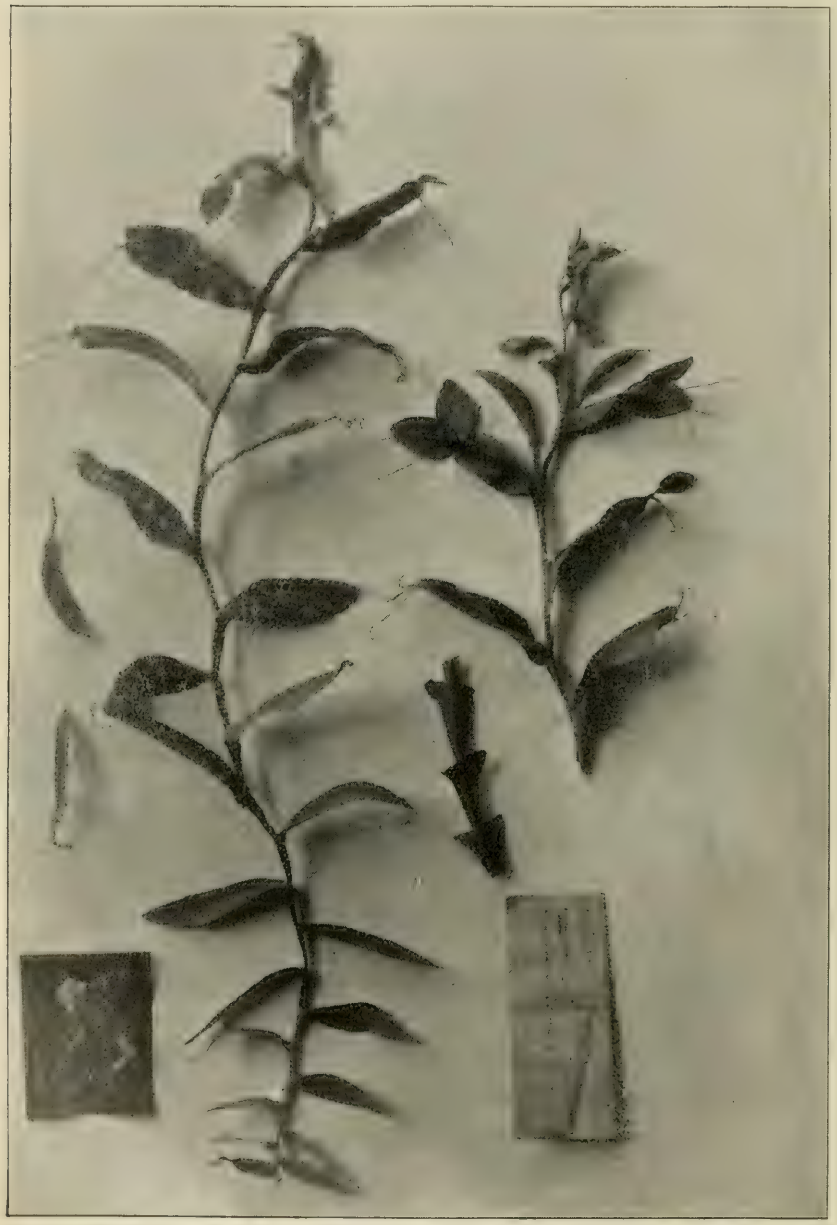

FIG. 181.—*Lathyrus ochrus DC.*

LATHYRUS MAGELLANICUS LAM.

Seeds of this species were received from two American seedsmen, but they proved to be the annual species, *Lathyrus sativus* L. The Cyclopedia of American Horticulture describes this species as follows: " Stem 3–5 feet long, smooth, angled, somewhat branched; leaflets ovate or oblong-linear; tendrils branched; stipules cordate-sagittate, broad; peduncles long, 3–4-flowered; flowers dark purple-blue. June, July. Straits of Magellan. . . . . . A strong-growing, woody, almost evergreen species covered with a bluish bloom. . . . . . . Var. *albus* Hort. . . . is the white form."

LATHYRUS LATIFOLIUS L.

Stems winged, 4–8 feet, glabrous; leaflets one pair, ovate-lanceolate, rather glaucous, mucronate, 2–3 inches long; tendrils branching; stipules broad ovate; peduncles many-flowered, longer than the leaves; legumes long, flat, reticulated lengthwise, 4–5 inches long; seeds roundish, smooth. Native of Europe, in woods. Flowers large, rose-colored, but horticultural varieties occur with white, dark purple, and striped flowers.

LATHYRUS NERVOSUS LAM.

Stems triangular, striated, 1–2 feet long; petioles with one pair of ovate, acute, mucronate, nerved, glaucous, glabrous leaflets, longer than the internodes; petioles very short; tendril branches long; stipules sagittate, nearly two thirds size of leaflets, nerved; peduncles many-flowered; calyx teeth unequal, upper ones shortest; pod 2½ inches, linear, glabrous, containing 7–8 seeds; seeds irregular in form, brown, with smooth coats. Native of the region about Montevideo. Flowers large, purple.

LATHYRUS PRATENSIS L.

Stems smooth, tetragonal, 2–3 feet; petioles with one pair of oblong-linear or lanceolate leaflets; tendrils usually unbranched; stipules ovate, shorter than the leaflets; peduncles many-flowered, twice the length of leaves; calyx nerved, teeth nearly equal; legumes compressed, obliquely reticulated; seeds globular, smooth. Native of Europe, in moist meadows. Flowers yellow.

HISTORY OF THE CULTIVATED LATHYRUS

The word " Lathyrus " is from the Greek Λα, *la*, augmentative, and ϑουρος, *thouros*, anything exciting, having reference to the qualities of the seeds of certain species. In Europe the species of *Lathyrus* are known as "*Gesse*," the sweet pea being known as *Gesse odorante*. The French know the plant under this name, or occasionally as *Pois odorante* and latterly as *Pois de Senteur.* The common *Gesse* of central Europe is *Lathyrus sativus.*

Of the one hundred or more species of *Lathyrus*, very few are in cultivation. Some — as, for example, the sweet pea — are of ornamental value; others, such as *Lathyrus sativus*, are of economic value as forage crops.

The species are all propagated by seed, and the perennial species by division also. Occasionally cuttings have been used, and possibly the method could be extensively adopted.

With the exception of the sweet pea, which requires the best of soil and culture, the *Lathyri* are not exacting as to soil. Some of the perennial species appear to thrive in a rather poor, dry soil and are useful in covering banks. The perennial species have long, fleshy roots, and when established they thrive for years without special care. In fact, these species are best left alone.

Descriptions of cultivated species

LATHYRUS SATIVUS L.

Blue-flowered lathyrus, or chichling vetch. An annual species, of easy culture. The flowers are sky-blue [Répertoire de Couleurs, the standard and wings forget-me-not blue 2–3 (217), back of the standard heliotrope 1 (188)] or pure white. The plant grows to a height of 2 feet and flowers early and profusely. The season is not long, but probably successive sowings would provide for a longer display of the bright blue flowers. At least two crops a year can be grown.

Don has the following to say of this species, which is a native of Italy, Spain, and France and has probably been cultivated from the earliest times: " In several parts of the continent a light, white, pleasant bread is made of the flower of this pulse, but it produced such dreadful effects in the seventeenth century that the use of it was forbidden by an edict of George, Duke of Württemberg, in 1671, which was enforced by two other edicts under his successor, Leopold, in 1705 and 1714. Divernoy Fabbroni says that in 1786 the government there cautioned the peasants against its use."

The effect of the use of the bread or seeds was that men and animals suffered from a rigidity of the limbs, which came on suddenly without any previous pain. The disease was regarded as incurable. Swine, horses, and pigeons suffered in this way, cattle grew lean; while poultry would not eat the food. Strange to relate, it appears that geese suffered no ill effects. It is recorded that if these seeds are mixed with one fourth or one half wheat flour, the bread made from them is harmless. The foregoing possibly explains the origin of the generic name.

LATHYRUS TINGITANUS L.

Tangier pea. This species is very distinct from the sweet pea, *L. odoratus*, and is sometimes cultivated in gardens with other annuals. Its culture is similar to that of the sweet pea, but, while the flowers are freely produced, they lack the range of color and the agreeable fragrance of the sweet pea. The species begins to bloom with the earliest of the sweet peas, but experience last year at this station would indicate that it does not produce flowers over so long a period. Success is dependent on prompt removal of the pods, for they develop rapidly. This plant comes from northern Africa.

LATHYRUS OCHRUS DC.

This species has pale yellow flowers, hence the common name, pale yellow pea. The plant was formerly known as *Ochrus pallida* Pers. Linnæus described it as *Pisum ochrus* and De Candolle as *Lathyrus ochrus*, the latter being now the accepted name. The species is of the easiest culture, but is not very showy nor attractive in bloom. It does not remain in bloom very long, but is of some interest botanically.

LATHYRUS SYLVESTRIS L.

This species is inferior ornamentally to other species, but is of some value as a forage crop. It grows well on poor, sandy soil, which it improves if plowed under.

LATHYRUS PUBESCENS HOOK.

One of the most ornamental species, but is not hardy. The flowers are a beautiful blue — in fact they are said to surpass Lord Anson's Blue — and are borne several in a cluster. The species was first cultivated by M. Andre in his garden at La Croix, France. The plant attains a height of 3 to 5 feet in cultivation. Early-sown seeds give plants that bloom the same season. This species may be increased from cuttings in the fall. In England the variety is apparently not hardy except in favored locations, and is recommended as a greenhouse plant. It was exhibited before the Massachusetts Horticultural Society March 20, 1906. Color plates are found in The Garden, Vol. 54, p. 353, and in Revue Horticole, 1895, p. 40. The latter is a better representation of the color of our species.

LATHYRUS MAGELLANICUS LAM.

In the old seed lists we find Lord Anson's Blue and Lord Anson's White. The plant most frequently sold under this name is *Lathyrus sativus*. The true species is a perennial, with woody stems 3 to 5 feet long bearing long, 3–4-flowered peduncles. The color is a purple-blue.

"The history of the species," says C. Wolley-Dod, "dates from the celebrated voyage around the world of Lord Anson in the ship Centurion in 1740–1744. The Centurion, with the crew in a dreadful condition from scurvy, reached the southeastern point of South America in the beginning of March, 1741 (equivalent in our season to September). The weather was then mild and bright, and it seems to have been at the entrance of the Strait Le Maire that this pea was first found."

Martyn's edition of Miller's Dictionary says of it: "Mr. Miller has a perennial pea, which he calls *Pisum Americanum*, or Cape Horn pea, from its having been brought by Lord Anson's cook when he passed that cape, where this pea was a great relief to sailors; but it is not so good for eating as the worst sort cultivated in England."

The plant is known to gardeners from the beautiful portrait in Sweet's British Flower Garden, Series II, Table 344. It seems that after its cultivation in the Chelsea Garden it was lost until Sweet's time, when his illustration was made from a living plant in Messrs. Osborn's nurseries at Fulham. After this it was again lost sight of for a long time, until it was reintroduced in 1899.

The Reverend Mr. Wolley-Dod says that the plants do not prove to be really perennial. Sweet makes the suggestion that, being a maritime plant native of a very stormy coast, it may require sprinklings of salt.

LATHYRUS LATIFOLIUS L.

One of the most valuable of the ornamental species, and the best known of the perennial species in this country. This plant is one of the best hardy perennials, being a vigorous, rank-growing climber bearing many-flowered peduncles in great profusion. The plant is suitable for covering low trellises or as a cover for rough places, low walls, rocks, and banks. It succeeds well in shade and grows rapidly. The plants resent frequent removal. There are several variety names in the trade, but the best, so far as we can determine them at present, are Pink Beauty, Delicata, Albus, and Splendens. Another name is Grandiflorus, which is confused with the species *L. grandiflorus*. The latter can be distinguished by the two(rarely three)-flowered peduncles, as the varieties of *L. latifolius* bear many-flowered peduncles.

LATHYRUS PRATENSIS L.

Common yellow vetchling, meadow vetchling, or tare everlasting. The old authors describe this as an ineradicable weed because of its creeping rootstocks. Later authorities recommend it as a food for cattle, since the quality is good and it produces a considerable quantity of succulent forage.

LATHYRUS NERVOSUS LAM.

This species, under the conditions at this station, made stems 1 foot long and did not flower. It is quite distinct in its plant characters. The species was discovered by Mr. Cameron, growing on rocky places near Montevideo in South America. It was first described by Doctor Vogel in Linnæa, Vol. 13, under the names *L. nervosus* and *L. trigonus*. It was first cultivated in England in the gardens of the Duke of Bedford, from seeds sent from Porto Bravo in southern Brazil. It is said to make a very satisfactory greenhouse subject, grown in pots and trained.

PART II. THE SWEET PEA IN BOTANY AND IN HORTICULTURE

"*Here are sweet peas, on tip-toe or aflight,*
With wings of gentle flush o'er delicate white,
And taper fingers catching at all things,
To bind them all about with tiny rings."

Keats.

HISTORY OF THE SWEET PEA

Botanical history

The earliest mention of the sweet pea was made in "Sillabus Plantarum Sicillæ-nuper detectarum a P. F. Franciscus Cupani" (Panormi, 1695). It is a very small work — duodecimo — and among the plants newly discovered is the "Lathyrus distoplatyphyllos hirsutis mollis, magno et peramoeno flore odoro." In 1696 the same writer issued "Hortus Catholicus Neapolitanus" (Neapoli). Father Cupani* exhibited considerable zeal in distributing this *Lathyrus* and in 1699 sent seed to Dr. Uvedale at Enfield, England, and to Caspar Commelin at Amsterdam, Holland.

Commelin published an illustration and description of the plant in his "Hort-Medici Amstelodamensis" (1697–1701). In his description he says:

"I am sowing seeds of this most elegant and very pleasant plant lately received from the Reverendo Patri Francisco Cupani, who was pleased to communicate with me and to send me these from Panormo, together with other somewhat rare seeds, in the beginning of 1699; which being sown, in the same year produced flowers and seeds, of which plant, for the sake of the elegance and pleasantness which it possesses, I have wished to set forth a delineation and description by that name which the Revendus Pater Cupani has proposed for it in the catalogue of the most learned and excellent Catholic Prince.

"This Lathyrus, an annual, rises to a height of 6 or 7 feet; the root is thin, the stalks compressed, solitary, projecting on both sides on these stand two wide and oblong leaves on a foot stalk, which is compressed, foliated, and raised, which footstalk ends in tendrils. From the wings of the leaves on longer pedicels spring butterfly-like flowers which are large and have a purple standard, the remaining petals are sky-blue. These flowers have a very pleasant smell."

Commelin adopted Cupani's name for the plant.

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* Father Cupani was a very devout and learned monk and an enthusiastic naturalist. He was born in 1657 and became a monk in 1681, his order being located in the vicinity of Panormi. In addition to the two purely botanical works mentioned above he prepared an illustrated natural history of plants, fishes, animals, and so on, entitled "Pamphytum Siculum." This work was published in 1712, following the death of Cupani in 1711.

The most noticeable thing about Commelin's drawing is the way in which the wings are spread laterally, possibly due to the liberties taken by the artist, for we also discover a seed pod near the top of the stem above the flowers.

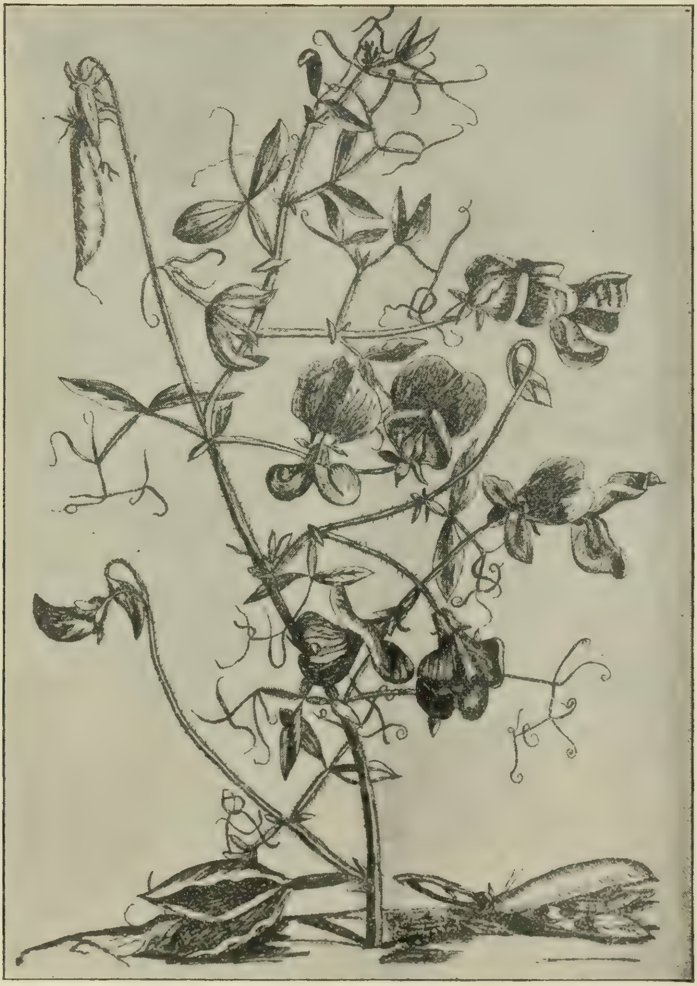

FIG. 182.—*The oldest drawing of the sweet pea, 1700. Commelin's drawing in Hort-Medici Amstelodamensis*

Dr. Leonard Plukenet,* in his "Almagesti Botanici Mantissa" (1700), gives a description of the sweet pea. A dried specimen of buds, flowers, and leaves, preserved in Plukenet's Herbarium which forms a part of the Sir Hans Sloane Collection, is the oldest specimen of the sweet pea in existence. This specimen must date from about 1700 and undoubtedly came directly or indirectly from the garden of Dr. Uvedale.

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* Dr. Leonard Plukenet (1642–1706). Apothecary at Westminster, where he had a botanic garden. Became superintendent of the gardens at Hampton Court, and Royal Professor of Botany. Published several botanical works.

John Ray,* author of "Historia Plantarum Generalis" (1688–1704), describes in the third volume of this work, which appeared in 1704: "Lathyrus Major e Siciliae; a very sweet-scented Sicilian flower, with a red standard; the lip-like petals surrounding the keel are pale blue. Its seed pod is hairy." In the same connection he refers to the plant as ".Lathyrus distoplatyphyllos hirsutis mollis, magno et peramoeno flore odoratissimo purpureo." The last word has been added to Cupani's description on the authority of D. Sherard.

In 1713 Mr. Petiver mentioned the plant in the Philosophical Transactions, in a paper entitled "Botanicum Hortense III" giving an account of divers rare plants observed that summer—A. D. 1713—in several curious gardens about London, particularly in the Society of Apothecaries Physick Garden at Chelsea. Petiver calls the plant *Lathyrus Siculus*, citing Boerhaave's "Index Plantarum quae Horto Academico Lugduno Batavo" (1710) as authority. The great Dutch naturalist considered his plant as identical with Cupani's *L. distoplatyphyllos*. Petiver describes the plants as coming from Sicily and having large, broad, sweet-smelling flowers, with a red standard (vexillum) and blue wing petals, or, as he describes them, "petalis labialibus," wrapping around the "rostrum," or young ovary. "This elegant sweet-flowered plant," continues Petiver, "I first observed with Dr. Plukenet† in Dr. Uvedale's most curious garden at Enfield, and since at Chelsea and elsewhere. Neither Gerard nor Parkinson mentions the plant, which must have been introduced after their time."

H. B. Ruppii, in "Flora Jenensis" (Francfort, 1718), places in a class of plants with irregular flowers, *Lathyrus Siculus* Ravini, and states: "In gardens they generally call it the musk-scented Lathyrus (L. moschatum). Sometimes it varies with a white flower." Now if we examine Ravini's "Introductio Generalis" (Lipsiae 1690–1699), we find that he figures "*Lathyrus Siliquis hirsutis* A., annual." He merely calls attention to the hairy pods, and this reference is extremely doubtful since there is a *L. hirsutis*, which is an annual, with hairy calyx and legume.

Thus far all the authorities give Sicily as the original habitat of the sweet pea; and the forms then known were a variety with a red or purple standard and blue wings, and, according to Ruppii, a variety with white flowers.

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* John Ray (1627–1705). One of the most distinguished of English naturalists. Author of many works, chief of which was "Historia Plantarum."

† Plukenet died in 1706, therefore this sentence doubtless refers to observations made between 1700 and 1706 and not to the summer of 1713.

Burmann, in 1737, published his "Thesaurus Zeylanicus," wherein he mentions: "Lathyrus Zeylanicus odorato flore amoene ex albo et rubro vario, Nobis. Lathyrus Zeylanicus hirsutis flore variegato odorato Herb. Hart. This plant differs from the L. odorato of Cupani only in the variety of the flower, and since it has been well described and set forth in Hort. Amst., part 2, p. 159, Fig. 80, we do not further describe it here, since also, in addition, these plants are well known to all since they frequently occur in our gardens."

Regarding the reference to Herb. Hart., Burmann says: "Hartog, or Hertog, is a herbarium which I keep and which contains very many most elegant Zeylanian plants, and was sent once by him from Zeylona to Cornelius Vossus, the gardener at Leyden." Burmann did not visit Ceylon, but received his specimens from others; and the early death of John Hartog,* who explored the island, prevented any correction of errors.

Linnæus, in "Hortus Cliffortianus," 1737, p. 368, gives the following:

"Lathyrus pedunculis bifloris, cirrhis diphyllis, foliis ovato-oblongis.

"Lathyrus siculus. Rupp. jen., 210.

"Lathyrus distoplatyphyllos hirsutis mollis, magno et peramoeno flore odoro. Comm. Hort. 2, p. 159, t. 80, Boer. lugd. 2, p. 42.

"Crescit in Sicilia. Sii nomini sides."

Linnæus published a work on the plants of Ceylon in 1747, but did not mention the sweet pea. In his "Hortus Upsaliensis, Stockholmiae" (1748) he referred to the sweet pea as follows:

"4 Lathyrus pedunculis bifloris, cirrhis diphyllis, foliis ovato-oblongis, leguminibus hirsutis. Hort. Cliff., 368.

"α Lathyrus siculus. Rupp. jen., 210.

"Lathyrus distoplatyphyllos hirsutis mollis, magno et peramoeno flore odoro. Comm. Hort. 2, p. 159, t. 80.

"β Lathyrus Zeylanicus. Odorato flore amoene ex albo et rubro vario. Burm. Zeyl., 138.

"Habitat: α in Sicilia; β in Zeylona.

"Hospitatur in ollis annua.

"Obf. Hacc coronaria, sauveolus, in β vexillum rubrum alae albae carina alba apice rusescente."

From the above it will be seen that the great botanist makes two varieties, and recognizes first the *Lathyrus Siculus* of Boerhaave but gives the name of Commelin, who adopted that of Cupani, as a synonym; second, he admits the Zeylanian *Lathyrus* wholly on the authority of Burmann. It is thought by some that the omission of this plant from his work on Zeylanian plants led the botanists to call the attention of Linnæus to the fact and that the above classification was made to correct this omission.

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*John Hartog was trained in the Leyden Garden and made a journey to Ceylon at the instigation of Boerhaave and of William Sherard, Director of the Garden. He sent plants and seeds to Voss. He died in the prime of life from exposure and unsuitable food.

Philip Miller, 1752, gives "Lathyrus distoplatyphyllos hirsutis mollis, magno et peramoeno flore odoro, Hort. Cath. Broadleaved, hairy, soft chichling with large and very beautiful, sweet-smelling flower, commonly called sweet-scented peas."

Linnæus, 1753, in his great "Systema Plantarum Europae," classifies the sweet pea as follows:

> "Odoratus 11. Lathyrus pedunculis bifloris, cirrhis diphyllis, foliis ovato-oblongis, leguminibus hirsutis. Hort. Cliff. 368, Hort. Upsal. 216, Roy. lugd. 363.
>
> "Siculus α Lathyrus Siculus. Rupp. jen., 210.
> Lathyrus distoplatyphyllos hirsutis mollis, magno et peramoeno flore odoro. Comm. Hort. 2, p. 219, t. 80.
>
> "Zeylanicus β Lathyrus Zeylanicus. Odorato flore amoene ex albo et rubro vario. Burm. Zeyl., 138.
>
> "Habitat: α in Sicilia; β in Zeylona."

Here is the first use of the term "Odoratus" as a distinctive name.

Kniphof, in his "Botanico in Originali" (1757–1763), gives colored illustrations of the pressed flowers of Painted Lady sweet pea. In Vol. II the stems bear two flowers, and in Vol. V there is only one flower on a stem. S. B. Dicks, who has written much on the history of the sweet pea, thinks that the first illustration is from a dried specimen, sent from Ceylon. He says: "The colors are those of the Painted Lady as now grown, but the standards are small and of poor substance, the wings being in each case the most prominent parts of the flowers."

Mr. Dicks, who is an English authority on the history of the sweet pea, says that no mention is made of the sweet pea in Paoli Bocconi's "Icones Plantarum Siciliae" (Oxford, 1674), which he regards as a rather remarkable fact. The writer has had an opportunity to examine this work, among others, and he finds that Bocconi does not mention *Lathyrus*, Vetch, *Orobus*, or, in fact, any of the Leguminosae. As proof that the *Lathyrus odoratus* did not occur in Sicily this work is worthless. However, Mr. Dicks called the attention of G. Sprenger to the facts regarding the origin of the sweet pea, and the latter undertook an investigation. Mr. Sprenger reported to Mr. Dicks as follows:*

"I retain that the plant is really a native of the two most important Italian islands, Sicily and Sardinia. I have just come from Sicily, where I could see the plant in the neighborhood of Corleone, a town lying in the interior on a range of hills, and in several other wild regions round about, together with other Papilionaceae. The plant has all the appearance of being of spontaneous form, and not an imported one. The above locality has been but very rarely visited and it is apparently to be excluded that L. od. was brought there. It is surprising that the Lathyrus has been found in but a few places, but this does not mean much. From what I could deduct, the plant grows in three or four places in Sicily and it has also been found in Sardinia.

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* "All about Sweet Peas," p. 21.

"Our most learned men retain that the Lathyrus is really an indigenous kind in Sicily, because it presents all the characters of being of spontaneous growth. The flowers of our kind are purple (purpurea), while those of Ceylon are rose-colored. This could be a variation due to the climate, but I was unable to find out if the Lathyrus varies or if the white-flowered variety is found growing spontaneously."

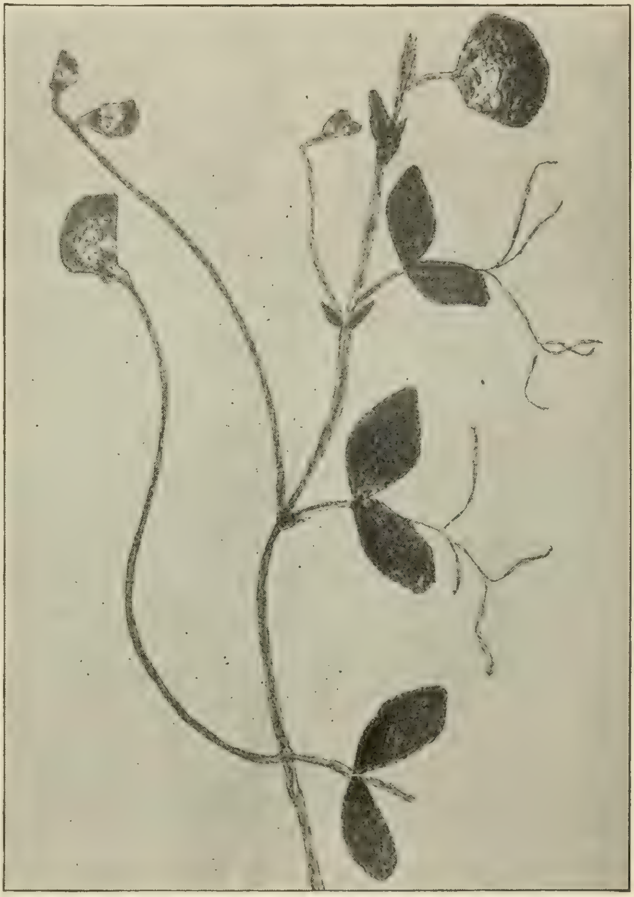

FIG. 183.—*Kniphof's figure of the sweet pea.* (*Kniphof, Botanico in Originali, 1757–1763*)

It has already been noted that the early writers considered Sicily as the native country of the sweet pea. Burmann was the first to catalog a sweet pea from Ceylon, which he admitted differed only in the color of the flowers from the *Lathyrus* described by Cupani. However, he proceeded to found a new species upon the sole character of difference in color of the flowers. Linnæus, writing a flora of Ceylon ten years later, did not describe a sweet pea from there. Neither of these botanists visited the island, and none of the later works on the plants of Ceylon, including those of Trimen, mention *Lathyrus odoratus* as native of that island.

The great mass of evidence, therefore, is in favor of Sicily as the original home of the sweet pea. The question arises as to how Burmann could have been misled. May it not have happened that Voss had seeds of the sweet pea which were accidentally mixed or included with the collection of Ceylon seeds? The color of the flowers was different from existing varieties, being red and white. That this would naturally be the direction of variation is shown by the fact that the first Cupid was white, while the second variety, Pink Cupid, was red and white. The first of Burpee's bush form was of this color, which is an extremely precocious color. It would appear, since the sweet pea is never found in Ceylon, and also from the fact that Burmann was aware that his plant differed only in color of the flowers from Cupani's plant, that *Lathyrus Zeylanicus* Burm. was only a variation from the original form received from Sicily in 1699.

British horticultural history

The earliest trade mention of sweet peas, according to Beale,* is found in the catalog of Benjamin Townsend (1724), who subscribes himself late gardener to Lord Middleton. He merely quotes sweet pea seed.

Robert Furber offered seed of the purple variety of sweet pea.

In "Twelve Months of Flowers" (1730), a set of engravings designed by Peter Casteels from the collection of Robert Furber, gardener at Kensington, and engraved by H. Fletcher, is to be found probably the first colored illustration of the sweet pea. The purple sweet pea is shown in the bouquet for the month of June. The form of the flower is very loose and irregular, with a small reflexed standard and very large wings.

In Miller's Gardeners Dictionary, first folio edition, 1731, is found the following, referring to the culture of *Lathyrus Tingitanus* and *Lathyrus distoplatyphyllos*:

"The fifth and sixth sorts are annual plants which are propagated only by seeds: these may be sown in March in the place where they are to remain for good; being plants that seldom will grow, if transplanted, except it be done when they are very young. These should be sown near a Pale, Wall, or Espalier, to which they may be trained, or, if sown in the open borders, should have stakes placed by them, to which they should be fastened; otherwise they will trail upon the ground and appear very unsightly; which is the only culture these plants require; except the cleaning of them from weeds. They produce their flowers in July and their seeds are perfected in August and September. But the best method to have them very strong is, to sow their seeds in August under a warm wall or hedge where they will come up in the autumn and abide the winter very well; and these will begin to flower in May and continue to produce fresh flowers until July or later, according to the heat of the season; and one of these autumnal plants will be as large as four or five of those sown in the spring and produce ten times the number of flowers; and upon these plants you will always have good seeds, when sometimes the other will miscarry; however, it is very proper to sow seeds at two or three different seasons in order to continue their flowers the longer; for the late-planted ones will continue blowing until the frost prevents them.

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* Gilbert Beale, in Gardening World, 1900, pp. 741, 742, and 765.

"The sweet-scented sort is the most valuable both for beauty and fragrancy of its flowers. Of this sort there are two other varieties: one of these has pale red flowers, which are called by gardeners Painted Lady peas; the other hath entire white flowers; both these may be allowed a place in the borders of the flower garden for the sake of variety."

From the preceding it is clear that three varieties were known at least as early as 1731. In the eighth edition of the Gardeners Dictionary, 1768, the same varieties are again noted.

James Justice, in the Scots Gardeners' Director (1754), criticised the catalogs of the Dutch seedsmen and nurserymen who were sending their catalogs throughout England. He says, "They are neither rightly named botanically or otherwise," and for illustration proceeds to quote from the "Caalogus van Schoone Bloem-Zaaden te Vinden," by Dirk and Pierre Voorhelm, "Bloemists te Haarlem": "No. 176 Lathyrus odorante flore albo et rubro variegato"; "No. 177 Lathyrus odorante flore purp. et rubro variegato."

Justice then proceeds as follows: "The first named is the Lathyrus angustifolius flore ex albo et rubro variegato odorato, mentioned by J. Bauhinus, 1650. This is the Painted Lady pea vulgo, a variety seminal of the 177 but not so sweet-smelled." Regarding No. 177 he says: "This is the Lathyrus distoplatyphyllos of Hort. Cathol., the sweet-scented pea vulgo; of this kind of pea there is both the purple and the white flowered forms."

In the catalog for 1778 of W. Malcolm, seedsman, of Kensington Turnpike, there were offered white, purple, and Painted Lady sweet peas.

The Universal Gardener and Botanist of Mawe and Abercrombie, 1778, gives under *Lathyrus*: "Varieties of, are, purple-flowered sweet peas, white-flowered sweet peas, variegated or Painted Lady sweet-scented pea."

The first evidence of improvement is noticed in the catalog of John Mason (original founder of the business of Cooper, Taber & Co.), published in 1793 at The Sign of the Orange Tree in Fleet Street. He offered black, purple, scarlet, white, and Painted Lady peas.

In Martyn's edition of Miller's Gardeners Dictionary, 1807, the sweet pea, with its varieties, is classified with the *Lathyri*:

"With two-flowered peduncles:

" Lathyrus odoratus........................Sweet Lathyrus or pea
L. Spec. 1032, Reich. 3. 465, Hort. Cliff. 368, Upsal. 216, Curtis Mag. 60
Floribus albus......................... White-flowered sweet pea
Alis carinaque albis, vexillo carneo...........Old Painted Lady pea
Alis carinaque carneis, vexillo rubro..........New Painted Lady pea
Alis carinaque pallide coeruleus, vexillo atropurpurea....Common sort
Carina pallide violacea, alis faturate violaceis, vexillo atropurpureo
Peduncles two-flowered, tendrils two-leaved, leaflets ovate-oblong, legumes hirsute.

" The sweet pea, as it is commonly called, is an annual plant which rises from three to four feet high by means of its long, clasping tendrils. The flower stalks come out at the points, are about six inches long, and sustain two large flowers which have a strong odour; and are succeeded by oblong, hairy pods having four or five roundish seeds in each.

" In the common sort the corolla has dark purple standards, with the keel and wings of a light blue. Other varieties are the white; the pink with a white keel and wings pale blush color; the rose-coloured standard with keel and wings pale blue; these that have a mixture of red with white or a pale blue are called Painted Lady dies. ' There is also a variety of the common dark sort with the keel pale violet and the wings dark violet, etc."

Page, in his " Prodromus " (1817), mentions a striped variety.

Thorburn, in 1824, catalogued the following varieties of sweet peas:

" Painted Lady—Lathyrus odoratus fl. carnea
White—Lathyrus odoratus fl. albo
Black—Lathyrus odoratus fl. obscuro
Purple—Lathyrus odoratus fl. purpureo
Scarlet—Lathyrus odoratus fl. roseo "

A yellow sweet pea is designated as *Lathyrus aphaca*. In 1827 the same firm offered a striped variety.

Roland Green, whose " Treatise on the Cultivation of Ornamental Flowers " (Boston, 1828) was the first distinctly floricultural book published in North America, speaks of sweet peas as follows:

"Pea, sweet (Lathyrus odoratus)—There are many species as to color and fragrance. These are annual. The Everlasting Pea (Lathyrus C. folius) is perennial and produces many clusters of showy flowers, and remains in bloom a long time. The seed should be planted early in the spring."

Edward Sayers, whose book "The American Flower Garden Companion" (Boston, 1838) was the second floricultural book published in America, gives in the appendix of the book the following list:

"Sweet pea, Painted Lady, Lathyrus odoratus	4 ft.	fleshed color
White sweet pea Lathyrus alba	2 ft.	white color
Purple sweet pea Lathyrus fl. purpurea	2 ft.	purple color
Scarlet sweet pea Lathyrus fl. rosea	2 ft.	scarlet color
Striped sweet pea Lathyrus fl. striata	2 ft.	striped color"

Thus we see that all the varieties were known in this country previous to 1840.

Mr. Carter (founder of Messrs. J. Carter & Co. of Holborn) offered in 1837 the five varieties previously offered by Mason, and also the striped variety.

In Mrs. London's "Ladies' Flower Garden of Ornamental Annuals" (1840) descriptions are given of a number of annual species of the genus *Lathyrus*, among them *L. odoratus*. Under the head of "Varieties" occurs the following: "There are six distinct kinds of sweet peas in constant cultivation, all of which, with very few exceptions, come true from seed. There are the purple, which has a standard of deep reddish purple, the wings pinkish, and the keel nearly white, and is a native of Sicily; the New Painted Lady, which has the standard deep rose colour, the wings pale rose, and the keel pure white, and is a native of Ceylon; the white sweet pea, which has flowers a pure white; the Old Painted Lady, which has the wings and keel white and the standard flesh-coloured; the blue, which has the wings and keel a pale blue and the standard dark bluish purple; and the violet, which has the keel a pale violet, the wings a deep violet, and the standard a dark reddish purple."

Between 1845 and 1849 the firm of Messrs. J. Carter & Co. introduced a New Striped Sweet Pea and a New Large Purple Sweet Pea.

In 1850 Messrs. Noble, Cooper & Bolton (predecessors of Cooper, Taber & Co.) introduced a New Large Dark Purple.

In 1860 Mr. Carter offered nine varieties, besides a yellow-flowered variety and the variety Blue Edged. The last-named variety was white, with a well-marked blue edge, and it was stated that it was the result of many experiments made by Major Trevor Clarke, of Daventry, in crossing a pure white sweet pea with the perennial bright-blue-flowered Lord Anson's pea, *L. Magellanicus*. Later, in 1883, under the name "Blue Hybrid," this variety received the First Class Certificate of the Royal Horticultural Society.

It was in 1865 that the First Class Certificate of the Royal Horticultural Society was first awarded to a new sweet pea. This was the variety called Scarlet Invincible, exhibited by Steven Brown, of Sudbury, and offered in Carter's catalog for 1866, where it was both described and illustrated. This was the first illustration of a sweet pea novelty ever published in a seedsman's catalog.

James Vick's "Illustrated Catalogue and Flower Guide" for 1870, under the division of Ornamental Climbers, gives the following varieties of sweet peas: Scarlet, Scarlet striped with White, White, Purple striped with White, Painted Lady, Blue Edged, Black, Black with Light Blue, and Scarlet Invincible.

The prices may be of interest, for Mr. Vick says: "I am so desirous to encourage the general culture of this sweet flower that I have made the price very low — the papers are large and the price by the pound and ounce about cost." The first five varieties were offered at 10 cents per packet, 20 cents per ounce, $3 per pound; Blue Edged, 30 cents per ounce, $4.50 per pound; the last three, 15 cents per packet, 40 cents per ounce, $6 per pound; mixed seed, 10 cents per ounce, $1 per pound.

About this time (previous to 1870) Messrs. Haage & Schmidt, of Erfurt, sent out Crown Princess of Prussia, the beautiful light pink variety. In 1873–1874 the same firm sent out Fairy Queen, which was a leading variety for many years. Butterfly, quite similar to Blue Edged, was introduced by Sutton & Sons in 1878. A color plate of this appeared in The Garden, Vol. 13, 1878, p. 44.

Messrs. Carter had the honor of publishing the first colored illustration of a new sweet pea to appear in a seedsman's catalog, when they sent out Violet Queen in 1877.

Prior to 1881 the following varieties had appeared: Purple, White, Painted Lady, Scarlet, Black, Purple, Striped White, New Painted Lady, Large Dark Purple, Yellow, Blue Edged, Scarlet Invincible, Scarlet striped with White, Black Invincible, Crown Princess of Prussia, Fairy Queen, Purple Invincible, Invincible Striped Violet Queen, Heterosperma, The Queen, Captain Clarke, and Imperial Purple. The opening decade (1880), however, was to witness great things for the sweet pea, for about this time two capable florists began work on the improvement of the flower. Those men were Thomas Laxton and Henry Eckford.

Mr. Laxton, of Bedford, commenced about 1877 and for several years worked assiduously in this field. In 1883 he won a First Class Certificate from the Royal Horticultural Society for the excellent variety Invincible Carmine. It is said that this variety is the earliest recorded from cross-fertilization, for, although the exact varieties are unknown, it was a cross of a red-flowered with a purple-flowered variety. Mr. Laxton appears to have made many crosses, using the best varieties known at the time as well as his own best seedlings. Among the varieties introduced by him are Etna, Madame Carnot, Invincible Blue, Carmen Silva, and Rising Sun.

After Mr. Laxton's death the work was carried on by his sons, who introduced Princess May and Sultan. They also made crosses of the Cupids, of which mention is made under that division of our subject.

Mr. Eckford began his work of improving sweet peas about 1870, while in charge of the gardens of Doctor Sankey at Boreatton. His collection consisted of the varieties known as White, Scarlet, Black, Painted Lady, and Butterfly. Later he started in business for himself at Wem, Shropshire, a small village but a place which he has made famous throughout the world. Here he worked, crossing and intercrossing all the varieties. His first notable result was Bronze Prince, which was exhibited before, and awarded a First Class Certificate by, the Royal Horticultural Society, August 8, 1882. This variety was sent out by W. Bull. Year by year the introduction of new varieties was forwarded, despite the claims of some persons during the earlier years that Mr. Eckford's varieties were no better than existing varieties. Steadily he kept at work, bringing out new varieties that were of improved size, form, or color. In the early nineties his varieties caused a sensation in America, and under the leadership of the Reverend W. T. Hutchins there was great enthusiasm in growing sweet peas for exhibition, and above all for home decoration. This supplied the required stimulus, largely lacking at home, for Mr. Eckford to put forth his best efforts, and the result is the remarkably long list of meritorious varieties that he sent out.

Aside from Bronze Prince, the following are some of the early Eckford varieties: Blue King, Charming, Duchess of Albany, Princess, Grandeur, Emperor, Black Prince, Leviathan, Rosalind, Maggie Ewing, Salmon Queen, Lavender Gem, Empress Victoria, Queen of Roses, Queen of Stripes, Purple Queen. How many of these were introduced we have been unable to ascertain.

In 1885 Mr. Eckford introduced Queen of the Isles and Grand Blue; in 1886 or previously, Cardinal, Indigo King, Princess of Wales, and Miss Ethel. These were offered in the United States by Joseph Breck in 1886. The varieties introduced in 1885, together with Miss Ethel, were also offered by Peter Henderson.

In 1887 Mr. Eckford sent out Duchess of Edinburgh, Imperial Blue, Isa Eckford, Orange Prince, and The Queen. These were offered by Breck the same year. Miss Hunt was also probably sent out this year. The following varieties were sent out in succeeding years:

In 1888, Apple Blossom, Boreatton, Mauve Queen, Queen of England, and Splendour.

In 1889, Captain of the Blues, Delight, Mrs. Gladstone, Mrs. Sankey, and Purple Prince.

In 1890, Alba Magna, Countess of Radnor, Lottie Eckford.

In 1891, Dorothy Tennant, Duke of Clarence, Empress of India, Monarch, Princess Victoria, and Senator.

In 1892, Emily Eckford, Her Majesty, Ignea, Lemon Queen, Mrs. Eckford, and Waverly.

In 1893, Blushing Beauty, Firefly, Gaiety, Lady Beaconsfield, Lady Penzance, Ovid, Peach Blossom, Royal Robe, Stanley, and Venus.

In 1894, Blanche Burpee, Duke of York, Duchess of York, Eliza Eckford, Meteor, Mrs. Joseph Chamberlain, Novelty, and The Belle.

In 1895, Alice Eckford, Captivation, Countess of Aberdeen, Crown Jewel, Little Dorrit, and Mikado. These were offered by the Reverend Mr. Hutchins in 1896.

In 1896, Coquette, Countess of Shrewsbury, Lovely, Mars, Prima Donna, and Royal Rose, which were offered in the United States in 1897 by Burpee and the Reverend Mr. Hutchins.

In 1897, Countess of Powis, Lady Nina Balfour, Prince Edward of York, Queen Victoria, Triumph, Salopian, and Shahzada.

In 1898, Black Knight, Chancellor, Colonist, Duchess of Sutherland, Lady Grizel Hamilton, Lady Mary Currie, and Prince of Wales.

In 1899, Countess Cadogan, Duke of Westminster, The Honorable F. Bouverie, Lady Skelmersdale, Mrs. Dugdale, Othello, and Sadie Burpee.

In 1900, Calypso, Countess of Lathom, Duchess of Westminster, Fascination, Lord Kenyon, and Mrs. Fitzgerald.

The two-hundredth anniversary of the introduction of the sweet pea was celebrated by the Sweet Pea Bi-Centenary Celebration in London in 1900. Including the introductions of that year, there had been two hundred and sixty-four varietal names of the tall-growing type of sweet peas catalogued. This included all the indeterminate variety names, as Purple, Purple Black, Purple Brown, Purple Striped, Light Blue and Purple, Red Striped, Striped Red and White, Striped Scarlet, Scarlet, Dark Red, Red striped with White, and so on; also, slight variations in color, form, and the like, as Striped Celestial, Light Gaiety, Extra Early Blanche Ferry, New Countess, and others, as well as the double sweet peas.

Out of this extensive list not more than one hundred and seventy-five varieties had been catalogued by any seed firm; the remainder were scattering introductions, some of which were not listed for more than one year. Mr. Eckford is responsible for one hundred and fifteen varieties. The relative superiority of the Eckford varieties is seen when we examine the lists of this period, for we find, for example, in Burpee's catalog for 1899, one hundred and forty varieties exclusive of doubles and cupids, and eighty of those are varieties originated at Wem. One fifth of the remainder are of the old varieties introduced prior to 1880. As late as 1907 we find that in Mr. Morse's list of the fifty leading varieties, based on the amount of seed of each demanded by the trade, twenty-eight of the varieties originated on Eckford grounds. In his selection of the best fifty varieties Mr. Morse included thirty-one Eckford varieties — a truly remarkable record of achievement for one man as against the field, especially when we take into consideration also the fact that after Mr. Eckford had " broken the type " many of the results obtained in California were rendered possible.

Mr. Eckford's further introductions are as follows:

1901, Coccinea, George Gordon, Honorable Mrs. E. Kenyon, Lady Ormsby-Gore, Miss Wilmott.

1902, Gracie Greenwood, Jeannie Gordon, Lord Rosebery.

1903, Agnes Johnston, Dorothy Eckford, King Edward VII, Mrs. Walter Wright.

1904, Mrs. Knights-Smith, Marchioness of Cholmondeley.

1905, Black Michael, David R. Williamson, Princess Maud of Wales, Romolo Piazzani.

1906, Henry Eckford, Queen Alexandra, Sybil Eckford.

1907, Agnes Eckford, Earl Cromer, Horace Wright, Maud Guest, Queen of Spain.

1908, H. J. R. Digges, James Grieve, May Perrett, Mima Johnston, Primrose Waved, Purple King, White Waved.

1909, Annie B. Gilroy, Dodwell F. Browne, Mrs. Charles Masters.

1910, Mary Vipan, Mrs. E. Gilman, Vicomte de Janze.

American horticultural history

The first American variety of sweet peas was that epoch-making variety, Blanche Ferry, introduced by D. M. Ferry & Co. in 1889. It was delineated by a colored plate, which was the first colored plate of a sweet pea to appear in an American seed catalog. This variety was derived from the Old Painted Lady.* Then followed Captain Sharkey (Breck, 1889), Joanna Theresa (Breck, 1889), Alba Magnifica (Henderson, 1891), Blushing Bride (Breck, 1891), and Emily Henderson (Henderson, 1893). The last-named variety was for many years the standard white, and florists especially preferred it. In 1894 W. Atlee Burpee & Co. introduced American Belle, and Breck sent out Harvard. In 1895 D. M. Ferry & Co. introduced Extra Early Blanche Ferry and Katherine Tracy. In 1896 Burpee sent out Daybreak, originated by the Reverend Mr. Hutchins, and also Grey Friar, Juanita, Oddity, and Ramona. The same year James Vick's Sons introduced the first of the double class in Bride of Niagara, which was a double strain of Blanche Ferry or its prototype. The sensational novelty Cupid, which is the most extraordinary departure yet found among sweet peas, was sent out in this year also.

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* For an account of the origin of Blanche Ferry, see Bulletin 319 of this station, page 625.

Mr. Burpee's introductions for 1897 included Aurora, Brilliant, Creole, Golden Gate, Maid of Honor, and Wawona. Mr. Lynch distributed California, Emily Lynch, and the Bride. The Sunset Seed Company introduced Golden Gleam and Red Riding Hood — the latter being the first of the Snapdragon type. Mr. J. C. Vaughan sent out America, the best of the stripes. Mr. Walker sent out Coronet. Mr. Breck distributed Snowflake, and the Reverend Mr. Hutchins sent out Columbia.

The new varieties introduced by Messrs. Burpee in 1898 were Dolly Varden, Lottie Hutchins, Modesty, Oriental, Sensation, and Stella Morse. In 1899 the same firm sent out Fashion, Gorgeous, Navy Blue, Pink Friar, and also the first of the bush type, namely, Grey Friar Bush. Mr. Walker sent out Oregonia.

In 1900 Burpee distributed Admiration, Surprise, Snapdragon, and Sunproof Salopian; in 1901, Majestic; in 1902, American Queen, Golden Rose, Salvation Lassie, and Reselected Extreme Early Earliest of All. Messrs. Ferry sent out Josephine White and Inconstancy.

In 1903, Janet Scott, Sue Earl, and Dainty were distributed by Burpee.

During 1904, Earliest Sunbeams and White Wonder were sent out by Burpee; Mr. Vaughan distributed Bridesmaid, Evening Star, Flora Norton, Florence Fraser, Mrs. George Higginson, Jr., Speckled Beauty, Sunrise, and Sunset. Messrs. Morse and Vaughan each introduced Nymphaea, and Morse sent out also Shasta.

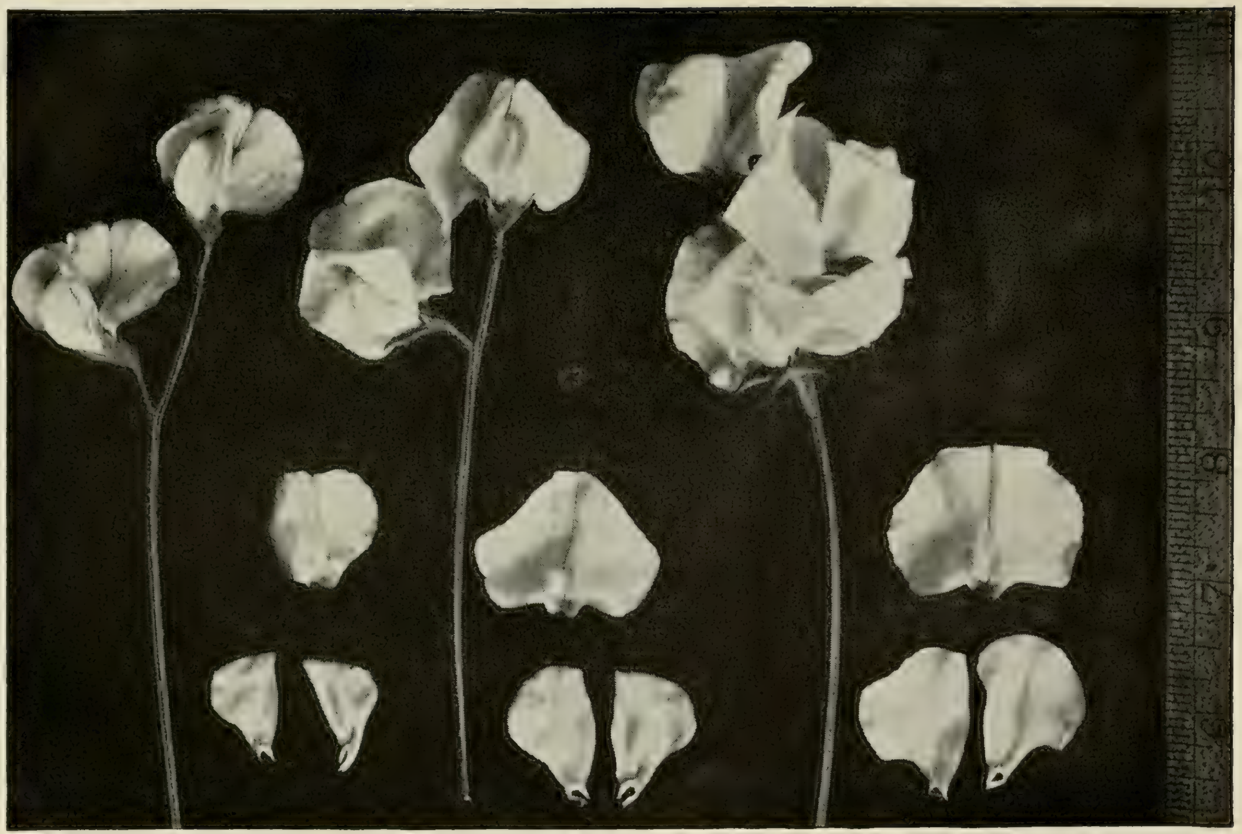
In 1905 Burpee introduced Mrs. Sydenham. (This name was dropped for Helen Lewis, which name was adopted by the English National Sweet Pea Society.) Morse introduced Helen Pierce. Henderson sent out Phenomenal and Domino.

In 1906 Burpee distributed Earliest White.

In 1907, Brilliant Blue was sent out by Burpee and Mr. Vaughan introduced Coral Gem.

The new American sweet peas for 1908 included Burpee's Apple Blossom, Spencer, Primrose Spencer, and White Spencer. Messrs. C. C. Morse & Co. introduced Florence Morse Spencer.

In 1909 Messrs. Morse introduced Captain of the Blues, Spencer, Flora Norton Spencer, and Tennant Spencer. The varieties Aurora Spencer, Asta Ohn Spencer, Beatrice Spencer, King Edward Spencer, Mrs. Routzahn Spencer, Mrs. Sankey Spencer, Ramona Spencer, Queen Victoria Spencer, and Lovely Spencer were catalogued by Burpee and by Morse for the first time in this year.



Queen of England Dorothy Eckford Etta Dyke

Evolution of the white varieties

Miriam Beaver, Marie Corelli, Senator Spencer, and W. T. Hutchins were introduced in 1910 by Messrs. Burpee and Morse.

The 1911 introductions include Dainty Spencer, Ethel Roosevelt, Rose de Barri, Purple Prince Spencer, America Spencer, and Emily Eckford Spencer.

Truly a long list. Among them are some of the finest varieties of sweet peas yet introduced, which indicates that the American growers can equal those of any country in the world. The cupid, or dwarf, pea, the bush and the winter-flowering types, all distinct in habits of growth, were first discovered on this side of the Atlantic. Since the introduction of Countess Spencer many excellent varieties of waved form have been developed, and this work of crossing and selecting is going steadily forward. Judging from the record made by the very small number of American breeders, what would America accomplish if she had even one half the number of English producers!

EVOLUTION

During the first one hundred years of the history of the sweet pea, only three varieties, or colors, were known — purple with blue wings, pale red with white wings (Painted Lady), and white. The black and the scarlet appeared in the last years of the eighteenth century. It is quite probable that the scarlet was very far from what we to-day conceive that a scarlet sweet pea should be. In Martyn's edition of Miller's Gardeners Dictionary, 1807, we find the white, the Old Painted Lady, the New Painted Lady (the latter with a rose-colored standard and pale rose wings), the Old Purple, and a variety having a violet keel and wings and a purple standard. Sayers describes the scarlet sweet pea as *Lathyrus flore rosea*, while the Painted Lady is described as " fleshed " color. From this it may be concluded that the New Painted Lady, a rose-colored variety, was sometimes called scarlet.

The first of the striped varieties was offered in 1837, and since that date this group has been augmented until the classification now includes Striped and Flaked (red and rose, purple and blue). This classification, however, does not express the real range of color in this group, for we have crimson stripes, as in America; red and rose stripes on white, in Aurora; red and rose stripes on primrose, in Jessie Cuthbertson; mauve stripes, in Gaiety; blue stripes, in Prince Olaf and Hester; maroon-flaked, as in Senator. The American growers have introduced the majority of the best varieties of this group, among which are America, Aurora, Columbia, Daybreak, Grey Friar, Juanita, Pink Friar, Ramona, and Wawona. Many of these are now procurable in the waved form.

The variety Blue Edged, the probable forerunner of the picotee forms, appeared in 1860. This was a white variety with a well-defined blue edge, a possible hybrid between *L. Magellanicus* and a white variety of *L. odoratus*. The variety, at all events, was the first to exhibit a distinct blue color among sweet peas. Later it was known as Blue Hybrid, under which name it won an award from the Royal Horticultural Society. Sutton & Son sent out Butterfly* in 1878, which somewhat resembled Blue Edged. The so-called " blues " that followed were Invincible Blue, Madame Carnot or Imperial Blue, and Captain of the Blues, all of which had considerable red in the standard. It was not until 1899 that a good blue appeared, in Navy Blue (Lord Nelson).

The first of the soft pink varieties was Crown Princess of Prussia, 1868–1869. Isa Eckford, Peach Blossom, and Lovely are the improved varieties of this color.

The efforts of the breeders of sweet peas have not all been directed toward the development of new shades of color; the form of the flower, also, has received attention. The earliest representations of sweet pea flowers show a loose, irregular bloom, with the edges of the standard turned back, that is, reflexed. Often, if not always, the standard had a notch in the apex and frequently in the margin. The standard, which is the principal part of the flower, has been improved in substance and the notches have been eliminated. The old type had a narrow base, and with the improvement noted has come a filling-out of the lower edges of the standard so that the outline approaches a circle.

In the efforts to produce varieties of the best expanded, or open, form, many beautiful hooded varieties were originated. While this form was condemned as inartistic by many sweet pea specialists, it nevertheless received a permanent place. Prima Donna, Lovely, and Countess of Radnor are of this form.

When many persons had reached the conclusion that no further advances in either form or size were to be expected, and that the efforts of future breeders would be directed toward securing new colors and more flowers on a stem, Nature demonstrated that she had other surprises in store. In 1901 the Countess Spencer variety was exhibited and caused a considerable sensation. The National Sweet Pea Society awarded it the highest honors. This variety was distinct from all preceding introductions because the standards and wings were waved. The flowers were very large and were borne in fours on stout stems. The variety was introduced in 1904.

The parentage of this variety has been given as (Lovely x Triumph 1898) x Prima Donna 1899. However, there appeared in 1905 a variety named Gladys Unwin, which has the same color but is smaller and less waved than Countess Spencer and which was a selection from Prima Donna without known crossing having been effected. These varieties, however, were forerunners of the new type which revolutionized sweet pea culture in England and has revived and quickened the interest in America.

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* See color plate in The Garden, 13 (1878), p. 44.

POLLINATION

We have previously noted that the pistil and stamens are enclosed by the partial coalescing of the two lower petals. A very slight pressure on the base of the keel will cause the pistil to appear suddenly in the tip of the keel; the stigmatic surface is usually covered with pollen. At the same time the stamens appear to view. If the pressure is released these organs disappear as suddenly from view.

Those who are looking for flower adaptations for the promotion of cross-fertilization would say at once that here we have a mechanism that is operated by the weight of a bee alighting on the keel; the pistil and stamens rise up, striking the bee on the body and receiving and giving pollen. Thus, as the insect visits flower after flower, natural cross-fertilization is brought about.

This, however, is not the case. In the first place, if we examine flowers in the bud stage we find the pollen ripe. The position and condition of the stigma change, for before the maturation of the pollen the stigma is below the anthers. A day or two later the stigma has risen to a position among the anthers and is viscid enough to hold the pollen grains. In another day or two it has grown beyond the anthers. Self-fertilization has taken place and the development of the legume has begun. This process has taken place before the flower is fully open. Sometime later the pistil is pushed out of the protecting keel by the developing pod.

Such is the normal fertilization of sweet peas, as observed on examination of the flowers. Attention has been called to the fact that the sweet pea stood practically still for one hundred years, and the question has been asked how this can be reconciled with natural cross-fertilization.

During the writer's experience in the field each season for three months studying varieties and recording observations, not a single instance occurred of a bee alighting on the keel of the flower, nor were any bees observed crawling between the wings. All the bees observed visiting the flowers alighted on the outside of the wings and, in practically every case, thrust the proboscis down between the right wing and the standard. In this connection it may be mentioned that the bees did not show a preference for any particular color, but flew from row to row and from color section to color section.

T. H. Dipnall has observed that bees attack sweet pea flowers. The bee (a yellow-and-white-banded species) alights on the calyx, crawls around it to a certain position, and cuts a hole through the calyx so that it can thrust its proboscis through and suck the nectar at the base of the pod. The reason is not clear why the insect prefers one side of the flower, since the structure is similar on both sides.

It is to be remembered in this discussion that sweet peas under glass in winter are not visited by bees, but every flower will set seed in sunny weather if the blooms are not kept cut.

Since the introduction of the waved type there has been much discussion about the difficulty in fixing varieties and the reasons for it. Some growers, having secured what was to all indications a fixed stock, have discovered, after sending it out, that it was not fixed. Some of these growers thought that this occurred only when the novelty was sent to California for working up a large stock of seed, or after it had passed into the hands of the California growers. One of the theories advanced to explain this was that a certain insect in California was responsible for some cross-pollination of flowers. In the trials at this station during the past season no difference was observed between English or American-grown stock, since we had seeds of novelties direct from the originators and our varieties were from the introducers.

Other growers say that bees visit the flowers, and they believe that crossing takes place in the waved type, which, it is maintained, does not produce normal flowers in that the pistil sometimes projects beyond the keel. It appears that, if this view is correct, the poor seedling of the waved type would not occur, or at least that the worse the fault of the flowers, the greater the crop of seed. Thus, the varieties that seeded freely would become cheap and drive out the others. The writer thinks that the results obtained by the seed growers contradict the theory. It appears that the poor setting of seed may be due to the fact that the pistil may grow out beyond the anthers before the latter are mature, and thus fertilization can be prevented by irregular development of the parts; otherwise, the pollen may be impotent in some varieties, but this does not occur so far as the writer has studied the reports of the sweet pea breeders. The writer did not observe any pistils showing the defect mentioned, but as the season here was very dry the plants did not make an exceptional growth which would be likely to express itself in abnormal flowers exhibiting the pistil. However, it was observed that some varieties seeded more freely than others. Most of the varieties were planted here in 1911 from seeds saved in 1910 and, knowing those that were fixed the previous year as well as those with rogues of certain colors, it is thought that some light may come on this matter of cross-fertilization, if there be any, in the sweet pea.

DWARF SWEET PEAS

The dwarf, or cupid, sweet peas are varieties that grow only five to eight inches high, with a spread of twelve to fifteen inches in diameter. The procumbent stems are stout, vigorous, short, jointed, and freely branching. The foliage is a deep green. The leaflets are small and the tendrils short. The flowers, which are of the size of those of the tall varieties, are borne, two or three in number, on short stems three or four inches in length.

The dwarfing has been accomplished by an extreme reduction in length of the internodes, for an examination of the plants reveals the fact that they have as many internodes as, or more than, the tall type.

The cupid sweet peas originated in 1893 at Santa Clara, Cal., on the grounds of C. C. Morse & Co., the largest growers of sweet pea seed. The plant was found growing among plants of the tall-growing variety, Emily Henderson. Naturally, this remarkable sport was preserved and its dwarf character proved to be so fixed that it is recorded that when Messrs. Morse grew seven acres of this novelty, in 1895, none of the plants reverted to the normal climbing type.

W. Atlee Burpee purchased the variety in 1894 and had it grown in England by James Douglas, where in June, 1895, it was exhibited before the Royal Horticultural Society and was given, by unanimous vote of the committee, an award of merit. The same year it was given an award of merit by the National Horticultural Society of France.

In Burpee's circular to the trade, July, 1895, this white-flowered variety was described It is a singular fact that but for this trade announcement a similar dwarf form would have been offered by Ernest Benary, of Erfurt, Germany, in 1896 or 1897, probably under the name of Tom Thumb White. It was such a complete description of his variety that the similarity was recognized and Mr. Benary published in his catalog the name of his novelty as a synonym of Cupid, thus preventing confusion.

In 1895 a similar dwarf appeared on the grounds of Henry Eckford at Wem, England. There is also some evidence that a similar form was found in 1895 among plants of the Old White grown in southern France.

This remarkable instance of synchronistic variation appeared in three or four widely separated localities within a period of two years. Singularly enough, so far as known, all these dwarfs had white flowers and white seeds and developed among white varieties.*

This novelty attracted considerable attention everywhere, especially among sweet pea lovers, and was offered to the public in 1896. Unfortunately Cupid, afterward known as White Cupid, the forerunner of the race, was white-seeded like the parent and germinated very poorly, especially the year of its introduction. It appears that even among white-seeded peas this is probably the most sensitive to unfavorable conditions during germination.

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* A notable and somewhat similar case was the appearance of the dwarf lima beans, but here we find the origin extending over a period of twenty years and the varieties are simultaneous only in the date of introduction. Moreover, we have very distinct varieties originating from very distinct climbing varieties of lima beans of two species.

Pink Cupid was discovered among plants of Blanche Ferry in 1895 and was introduced by Burpee in 1898. Burpee had purchased the stock of 1,068 seeds, for which he reported paying the sum of $1,500 — probably the largest sum ever paid for a new variety of sweet peas. This variety was similar to Blanche Ferry in all characteristics except its dwarf habit.

A yellow sport found among White Cupid was introduced by Burpee in 1899 as Primrose Cupid.

During the seven years following the introduction of the original Cupid sweet pea a great number of varieties appeared, reproducing all the known colors and types of the tall-growing varieties. " Several of our best Cupids," says Morse, " were found originally in the tall varieties but the majority were developed by crossing."*

Laxton Brothers, of Bedford, England, began crossing upon Cupid soon after its introduction, and at the bicentenary celebration in 1900 it was reported that this firm had dwarf counterparts of Purple, Dark Blue Striped, Captain Clarke, Rose, Light Blue Striped, Invincible Blue, Invincible Carmine, Invincible Red, Invincible Black, Sultan, Rising Sun, Boreatton, Princess Beatrice, Princess May, Princess of Wales, Etna, Vesuvius, Indigo King, Pale Madame Carnot, Waverly, Primrose, Carmine Striped, and Countess of Radnor.

It will be noticed that many of these were representatives of tall varieties that were obsolete or were passing out, and of course were not equal to such varieties of Cupid as Beauty, Alice Eckford, and Firefly, which had been introduced by that time.

Varieties of cupid sweet peas

White, or " Cupid," 1896
Pink, 1898
Alice Eckford, 1899
Beauty, 1899. Similar to Eliza Eckford
Primrose, 1899
Boreatton, 1900
Countess of Radnor, 1900
Firefly, 1900
Apple Blossom, 1901

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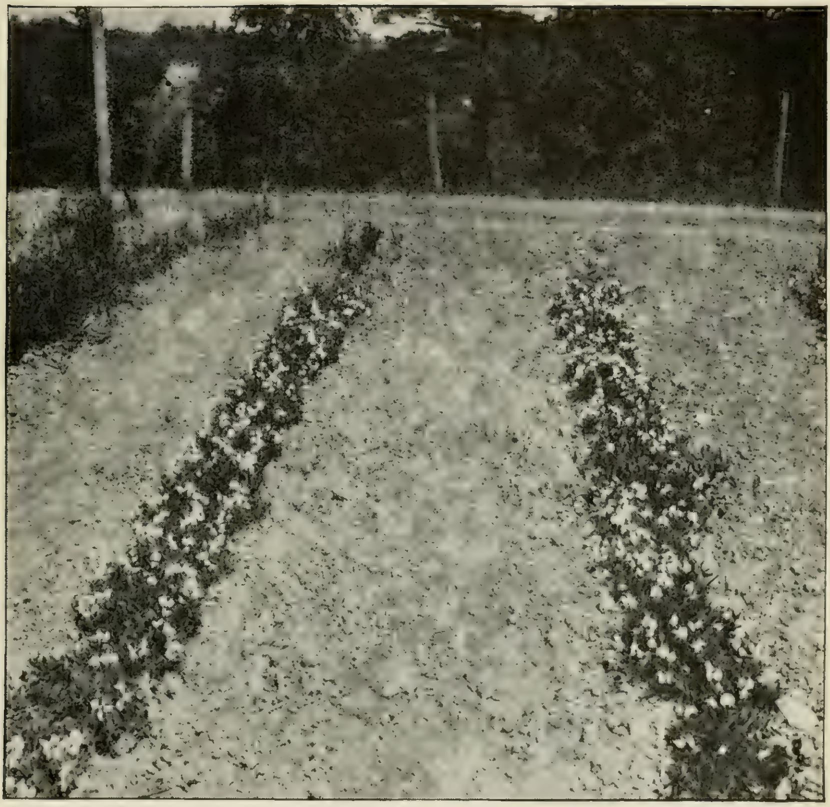
* Waldo E. Rohnert reports the results of crossing the tall varieties upon the Cupid sweet pea in Bulletin 127 (1897), Cornell University Agricultural Experiment Station.



Dwarf sweet peas

Captain of the Blues, 1901
Chamberlain, 1901. Similar to Mrs. Joseph Chamberlain
Royalty, 1901. A dark Royal Rose
Stella Morse, 1901
America, 1902
Her Majesty, 1902
Lottie Eckford, 1902
Bridesmaid, 1903
Enchantress, 1903. A dark Lovely
Mauve Queen, 1903
Extra Early Blanche Ferry, 1903
Sadie Burpee, 1903
Lady Mary Currie, 1904
Prima Donna, 1904
Prince of Wales, 1904
Salopian, 1904
Emily Eckford
Lovely
Navy Blue
Waverly
Ovid
Ramona

Unpopularity of the type

The cupid sweet peas have never been very popular for several reasons. Many persons apparently expected this dwarf type to furnish long-stemmed blossoms for cutting, thus relieving them of the necessity of providing supports for the plants. The short stems of this type were therefore a disappointment to such persons and they unhesitatingly condemned it for any purpose. In answer to the claims made that the plant was adapted for use as an edging or for bedding, it was urged that the blooming period was too short — not allowing for the fact that the dwarf type behaves similarly to the tall type and ceases to bloom if the pods are not removed. For no other reason this sweet pea has been ignored by many seedsmen, while some inferior trailing plants are still offered in their catalogs. The dwarf sweet pea has the advantage of many border plants in its great variety of colors.

In part the unpopularity of the plant has been due to the fact that the White Cupid did not germinate very successfully, especially the first year of its introduction, thus affecting the popularity of this whole race. The black-seeded varieties give a high percentage of germination, so that poor germination is not an inherent fault of the race.

The dense foliage and growth of the plants make a thick carpet over the surface of the ground, and in a wet season the result is usually failure. The flower buds drop off and the plants do not thrive even if they do not become subject to disease. The foregoing reasons explain why this type has not been very successful in English gardens.

In California, where the summers are long and dry, the cupid sweet peas thrive. During hot, dry summers in the Eastern States, when the tall varieties are subjected to very trying conditions, the cupid sweet peas grow and bloom abundantly. In 1910, ten 20-foot rows of different varieties of the dwarf type were grown at this station. When the tall kinds were having a struggle with the drought under a temperature of ninety degrees or more, the cupids, in the highest and driest position in the field, grew and blossomed profusely. They were admired by all who saw them and many questions were asked as to what they were, whether they were of recent introduction (new), and where they could be obtained.

The conditions necessary for the successful culture of the dwarf sweet peas appear to be a rather dry, moderately rich soil, a dry, hot season, good cultivation, and prompt removal of the withered flowers and pods. The seed may be sown in single rows, twin rows, or scattered in a broad drill ten or twelve inches in width. For the purposes mentioned the distinct colors are preferred. Among the best varieties are White, Pink (Blanche Ferry Cupid), Countess of Radnor, and Prima Donna.

GARDEN CULTURE OF THE SWEET PEA

The soil

Site.— An open, sunny location should be chosen, so as to provide plenty of light and air. Plants grown in too shady a position are weak and spindling in growth, producing few flowers. A little shade from the scorching, midday suns of July and August is desirable, especially for preserving certain colors.

Any ordinary garden soil is suitable for sweet peas, provided it is sufficiently drained so that in periods of excessive rains the water will not lie on the surface, causing the plants to become yellow and the roots to decay, or starting mildew. Soil suitable for the growing of vegetables will give fairly good results, but extra care in the selection and preparation of the soil will be repaid in larger flowers, longer stems, better colors, and a longer blooming period.

Preparation.— The sweet pea is a deep-rooting plant, and in order to provide suitable conditions so that the effects of drought are overcome the preparation must be deep and thorough.

Whatever the soil, unquestionably the best preparation is made by trenching the soil in the autumn.* When, owing to expense, the soil cannot be completely trenched, practically the same result may be accomplished by digging a trench fifteen inches wide for each row. The soil should be broken up to a depth of fifteen inches to two feet, and on some soils even deeper. Unless the soil is very uniform in composition, it is disastrous to bring the bottom soil to the surface; but this should be turned over in the trench, mixing with it, if heavy and compact, rather coarse stable manure or litter. Sometimes leaves are available for placing in the bottom of the trench. The use of these materials in subsoil promotes drainage, as well as improves the soil.

If a good layer (four inches) of half-rotted stable or cow manure is placed between the top and bottom spadefuls, and the top soil, if heavy, made light with old manure, an excellent preparation has been made. The office of the manure is not only to increase the store of plant food, but also to increase the water-holding power.

Bone meal, applied at the rate of one ounce per yard of trench, is essential.

A good dusting of air-slaked lime applied while working the soil in the autumn is very beneficial. Many soils that have been cultivated for a long time are acid, so that leguminous plants, such as clover or sweet peas, will not grow, or, at least, do not thrive. Lime corrects this acid condition and, furthermore, it releases plant food that would not otherwise be available in soils which are not acid. Clay soils are made more open and porous by the use of lime.

Deep preparation not only promotes available fertility, but also increases the area in which moisture and nourishment may be found, and the plant responds by sending feeding roots in all directions.

While it must not be inferred that sweet peas can be grown only in deeply trenched and prepared soils, it is true that only under exceptional conditions are the results satisfactory when this is not done. Uniformly, year after year, the sweet peas with the strongest root systems will produce the finest flowers during the longest period.

The seed

Some white-flowered varieties have white or light-colored seeds, and some have black seeds. The white seeds often give trouble by rotting in the soil — especially if planted early when the soil is cold — or because their germinating power has been impaired; also they frequently split in the pod before harvesting and in this condition are likely soon to lose their vitality. For the foregoing reasons it is advisable to sow seeds of this color rather thicker than, or not so deep as, the black-seeded varieties.

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* The texture of clay soils is sensibly altered when fall-plowed or stirred and exposed to the action of frost.

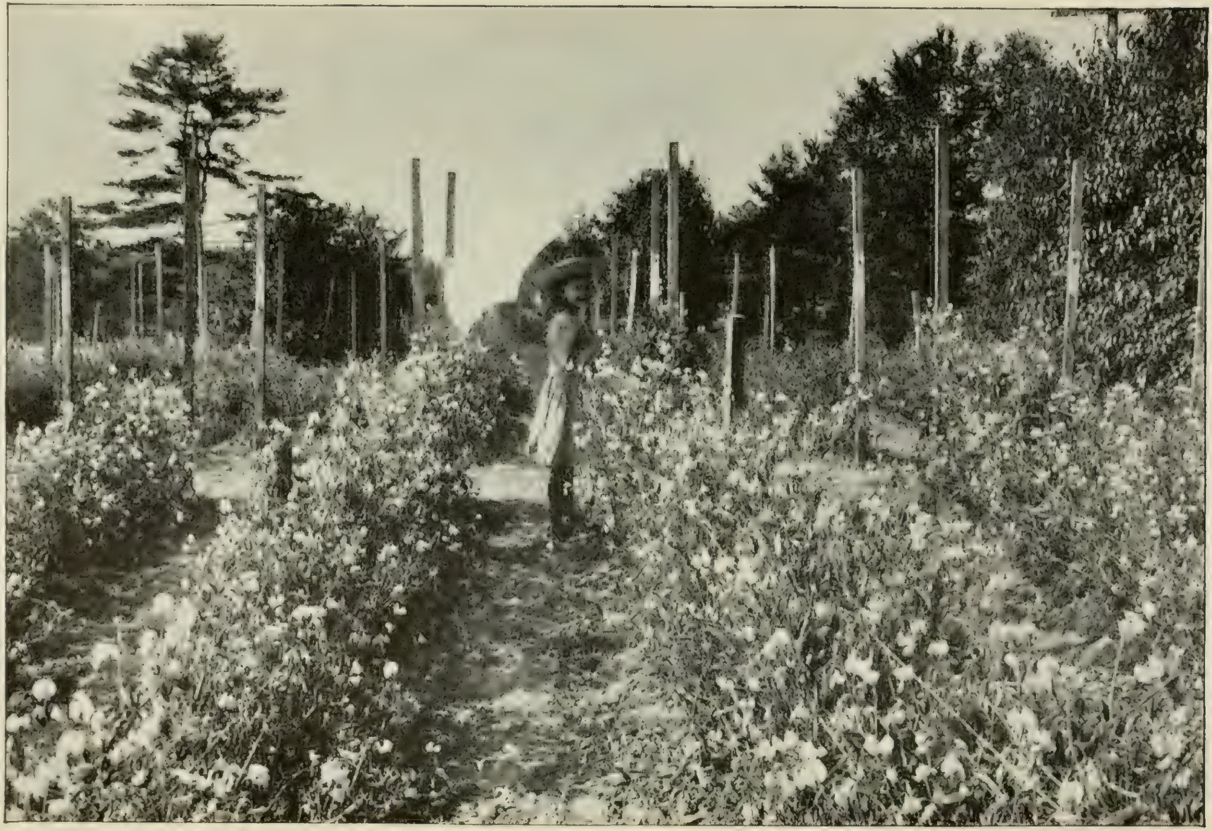
In some seasons, sweet pea seeds are slow in germinating. It is well to examine such seeds in order to ascertain their condition. If the seeds are found dormant but still fresh and plump, the seed coats should be cut with a sharp knife and replanted, when they will germinate well. This difficulty is not confined to the sweet pea, but some of the other *Lathyri* behave similarly. The trouble usually follows a very hot, dry season, when the seed becomes so excessively ripened as to render the seed coat impervious to water. Sometimes, in order to expedite germination, the seeds are soaked; a better method for the amateur is that recommended by Mr. Hutchins, the most prolific writer on sweet peas in America, who places the seed packets in moist earth for seven or eight days, then takes them out and examines them. The swollen seeds are planted and the others cut with a knife.

Planting

Fall planting.— In the season under discussion, the finest and the earliest flowers were secured from plantings made in the fall. The preparation of the soil is the same as that already described, except that the soil is firmed and the trench filled level. On this a trench, or furrow, two inches deep is made, and the peas are planted at least as close as one seed every two inches. The row should be slightly ridged up so as to prevent water from standing and, as stated in the beginning, it is essential that the location be on a well-drained site. When the ground freezes, a mulch of manure is placed over the row. In the spring when the bright weather comes, the plants should be examined in order to see whether they are growing or whether the soil is soggy and cold. In either case, the mulch should be removed from over the row, and should be left in the center so that, in case any weather should come when the safety of the plants is at all endangered, the old mulch may easily be applied to protect them.

The seed of the standard varieties of sweet peas is cheap, and the advantage gained in obtaining early flowers, if the plants survive the winter, is worth the effort.

Spring planting.— As soon as the frost is out of the ground and the soil in workable condition in the spring, a heavy application of superphosphate of lime should be made and raked in. Care should be exercised not to get the soil too loose, and for this reason it is best to confine all stirring of the soil to smoothing the surface. Especially is this true with light soils, which, if stirred deeply in the spring, must be well firmed. Heavy soils that are likely to bake may be improved by working in a light dressing of old, thoroughly rotted manure.



Countess Spencer sweet peas. The fall plantings, July 29, 1910

Sweet peas sown in pots versus those sown in open ground

Sweet peas should be sown just as early in the spring as the soil is dry enough to work, even though it be certain that heavy frosts may follow.

The writer thinks that one reason why even the most inexperienced amateur usually has so good average results with sweet peas, is that when this individual gets his annual "violent attack of gardening fever" in early spring, he begins his operations at just the right time for sweet peas to go into the ground.

An essential requirement in growing sweet peas is to plant early, while the atmospheric conditions are such as to prevent top growth until the plant has started a vigorous root development. The result is that, when warmer weather comes, the top grows strong and heavy, the plant branches out, and throughout the season this increased vigor is seen. Experiments made by sowing seeds every ten days from the earliest practicable date until the end of May show this result conclusively.

Depth.— If the preparation of the soil has been made in the fall, it is best only to smooth the surface of the trench and plant in this. When the preparation has been made in the spring the soil must not be left too loose — a condition that may easily occur if a deep trench is made and only loosely filled with soil and manure.

One method recommended is to hollow out a broad trench, twenty-four to thirty inches wide and two inches deep, and then sow the seed one inch deep in single or double rows. The trench should be kept open for six weeks in order to retain the water. This system is very good in a garden where all cultivation is given by hand; but where many rows are grown and cultivation is done with a horse and cultivator, it is manifestly impossible to make or to maintain such a trench. Furthermore, when horse cultivation is to be used there would be difficulty in keeping the young plants, if planted below the surface, from being covered during the early cultivations. Therefore, planting on the level is necessary in field culture. It is advisable, however, in garden culture, to plant so that when covered the row will be two inches below the ordinary level.

Shall the planting be in single drills, broad drills, or double rows or drills? It matters little, provided sufficient room is allowed for the growing plants.

Amount of seed.— The latest American book advises sowing one ounce of seed to a fifteen-foot row, and later thinning the plants to six inches apart. Now let us see what this means. Since an ounce of seed contains three hundred to three hundred and sixty seeds, if in a single drill the seeds will be three fifths to one half inch apart. If only seventy-five per cent of the seed grew (which is a very low estimate), one hundred and ninety-five to two hundred and forty of the seedlings must be removed in thinning to the distance given. In other words, the author of the above-mentioned book advises planting ten to twelve seeds in order to get one plant, or leaving about ten per cent of the seed to grow. In the plantings at this station, one hundred seeds, except when doubtful, were sown to a twenty-foot row, or one seed every two inches, and this is heavy seeding. Under the latter system an ounce will plant fifty to sixty feet of row and, if the seed is good, it should plant still more.

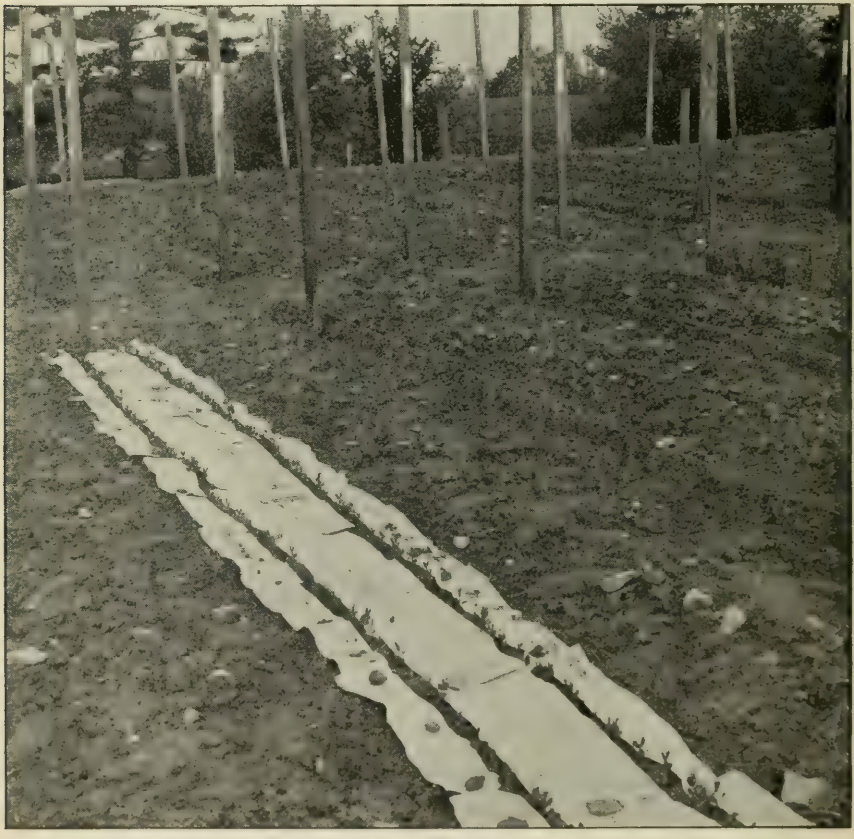


FIG. 184.—*The double-row method of planting*

Sowing in pots for outdoor bloom.— Many English growers practice sowing in pots under glass, hardening the plants in frames, and planting out. From the writer's experience with three varieties during the year under discussion, he is inclined to look on this method with favor, especially in growing high-priced novelties or varieties for exhibition. In fact, if the results of experience and observation at this station in 1910 are to be relied on, it would appear that the successful exhibitors of the future will obtain their flowers from fall-sown or pot-grown plants.

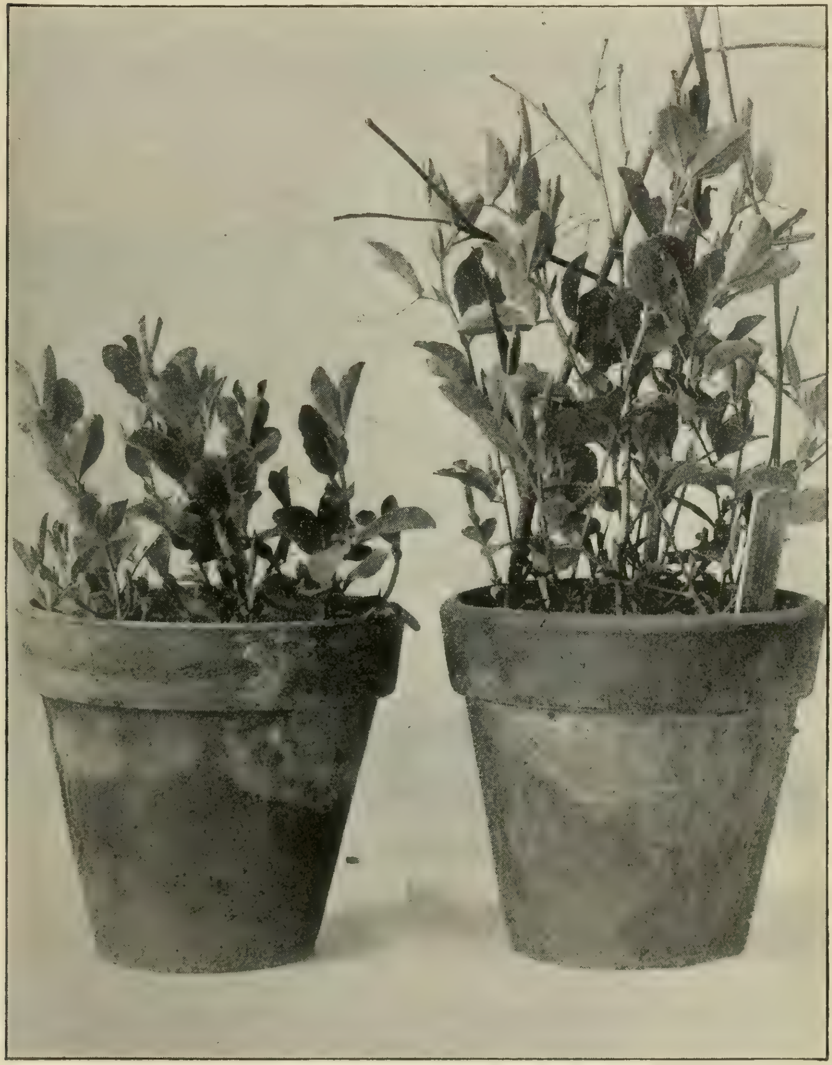


FIG. 185.—*Sweet peas started in pots*

In order to secure suitable plants, six seeds should be sown in four-inch pots, using light, rich soil. The best time to sow sweet peas in this manner is in March. When the plants are two or three inches high they should be given supports of short twigs and placed in a cold frame. Here they should be given plenty of air at every opportunity, in order to secure a short, sturdy growth. If the plants do not catch hold firmly, they may be tied with raffia. When spring begins and the soil is in good condition, the pots may be planted in the open, one foot apart in a single row or two feet apart in a double row. In the latter case, the plants alternate as shown below:

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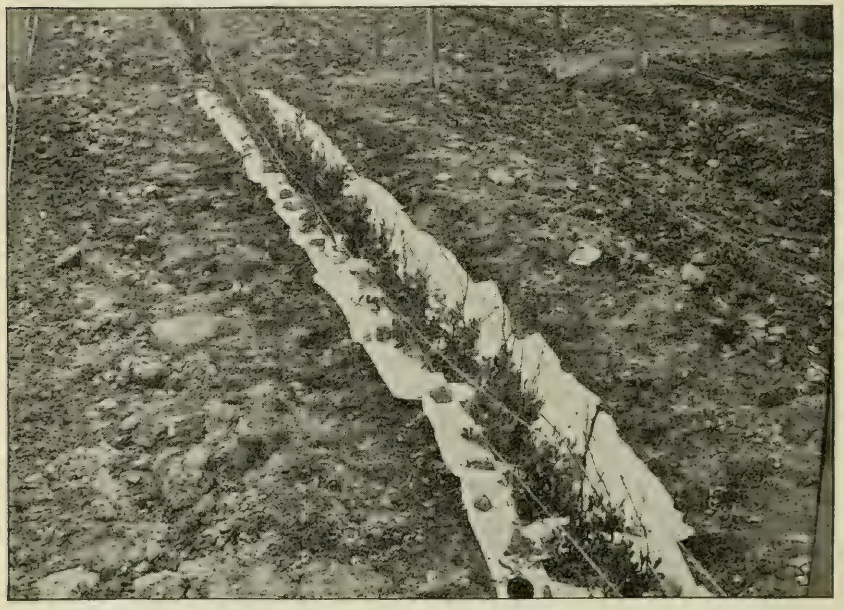


FIG. 186.—*Sweet peas transplanted from pots*

Supports

Sticks. — Among English sweet pea growers there is considerable unanimity of opinion that sticks form the best support for sweet peas. The replies of fifty-two leading experts, published in the Sweet Pea Annual for 1907, show that forty-three growers favor sticks (generally hazel sticks), five favor wire netting, two favor either sticks or wire netting — and, if the netting is new, paint it — one prefers sticks and string, and the remaining one, a correspondent from British Columbia, uses telephone wire and string.

In this country, where good twiggy boughs can be obtained, such boughs unquestionably form the best support to use since they are the most natural.

In many places birches can be obtained in lengths of twelve to fourteen feet. These may be prepared in the lengths desired.

How tall should the support be? The grower is the one to determine that. If the soil has been prepared properly and the plants look strong, and if the grower sees that the plants are watered and given every care, then the support should be six feet high. If the soil is only moderately fertile or has not been deeply prepared, or if the grower does not intend to keep all seed pods picked off or cannot water the plants in order to overcome drought, the support should be kept down to four feet. The variety has something to do with the height of the support, whatever the care bestowed, some varieties being naturally dwarfer growers.

The sticks should be cut in late winter or very early spring, so that they are still rather green and tough enough to bear the load until the end of the season. They should be inserted in the soil at least a foot, because when clothed with vines to a height of six feet a strong windstorm exerts a tremendous leverage on them. Unless the sticks have been inserted deeply, or if they have become too dead and brittle, the row will go down under the force of the wind and the great weight of the wet vines. In order to guard against disaster, strong stakes are sometimes placed every ten feet and wire is run lengthwise through the sticks and fastened to the stakes. It is desirable to have the sticks bushy at the top, so that they spread out more than at the base; if not naturally so, leaning the sticks alternately outward will produce this result. This gives greater freedom for the vines when in flower.

After the sticks are inserted, a better effect is produced if the tops are clipped to a level and straggling ends are cut back. If the sticks are not " feathered " sufficiently at the base for the plants to get started up on them, the clippings from the tops may be inserted between the tall sticks. Some growers make a practice — and it is a good one — of providing a light support when the plants are one to three inches high, and later placing the tall sticks. For the light support they often use old raspberry canes or the old stems of our wild aster — in fact, anything of a light, much branching character. This affords protection from high winds when the plants are small.

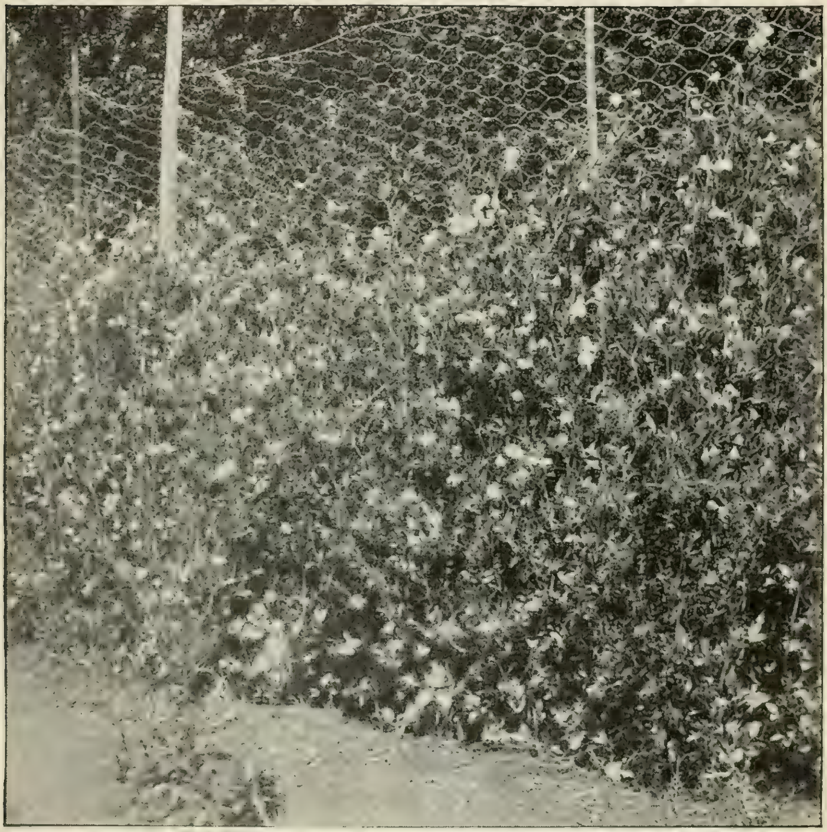
Netting.— When other systems of supporting are to be employed it is quite imperative to provide a support of small, short twigs as soon as the seedlings begin to produce tendrils. This method prevents the rain from beating the small plants down, and enables them to get up to the other support. In city gardens, owing to the difficulty in procuring suitable sticks, wire netting makes a very satisfactory support. The peas do not cling to it so well but it is cleaner and neater in appearance, which is a compensating advantage. The large mesh, four-inch, is preferable, but in many places this is not procurable and the ordinary chicken netting, or fence, is used instead. Strong stakes at intervals not to exceed ten feet are used to support the netting. One advantage of wire netting is that if stakes six feet high are used, a forty-two- or forty-eight-inch strip of netting may be placed in position, and, if the season or soil is favorable and the peas grow above this, a narrow strip of netting may be added or a string or wire stretched from stake to stake over the row. A well-galvanized netting can be used repeatedly for several years, and will last longer if taken off in the fall and stored.

String.— Another method is to construct a support of wire and string, or of string alone. The ingenious grower can construct all sorts of fanciful designs with wire and string on posts set not over ten feet apart. Sometimes a wooden strip is nailed horizontally at the top and bottom, but often a wire is used instead. From bottom to top, between these horizontal strips or wires, a homemade network can be made. When the peas are grown in double drills, the construction described above is made on each side in box-like form.

When sweet peas are grown in single drills especially on a considerable scale, the best and cheapest support is one made by placing stakes at intervals under ten feet, and winding strong cord around the row from stake to stake. The strings are placed six to eight inches apart, or closer if necessary. If the stakes are too far apart — ten feet or more — the string will stretch after becoming wet or even damp, and the plants will fall over. If appearance is not an object anything will serve for stakes, as tailings from the mills, poles, and the like. When neat stakes are driven in the row this method is very good in the garden as the vines cling to the string better than to wire netting, which becomes hot; also, the supports when string is used may be made as tall as needful for the peas. Thus there are only the tops of stakes showing above a row of short vines, in place of a row of uncovered netting. At the end of the season, if the stakes are worthless the whole support, as well as the sticks, can be burned.

Sweet peas are sometimes grown in clumps and must be supported. Here again sticks are often favored, especially where the plants occupy a circle six or more feet in circumference. Wire netting cut in suitable lengths may be made into cylinders for clumps of any size.

Other methods.— Henry Eckford advertises a sweet pea support consisting of four stakes, each in two pieces three feet long. These are placed ninety degrees apart around a circle and three-foot netting is stretched around them. When the peas reach the top, if greater height is needed the upper half of each stake is fitted by means of a mortise into the top of the one already driven and another strip of netting is put on.



Sweet peas on wire netting

Sweet peas grown in clumps

An English seedsman advertises sweet pea ladders for use in training the vines in garden decoration. The ladders are made six feet long and six inches wide. They are used perpendicularly, the tops being fastened to a horizontal wire. Two rows are supported by leaning the tops together and fastening them to an overhead horizontal wire. Plants grown in circles may be brought together in the center at the top, where the ladders are fastened to a center stake. Sweet pea arches are sometimes made. These, of course, should never be over six feet high or they would seldom be covered.

Now the ladders can be easily made with two No. 10 galvanized wires, rose stakes of the proper length, and some smaller wire for the rungs or cross wires. The arches can also be made complete, if desired, by merely making the ladder long enough and bending it into the form of an arch.

Cultivation

Tillage, watering, and mulching.— Frequent cultivation should be the rule in growing sweet peas. A very liberal use of the hoe or the cultivator in maintaining a loose, shallow surface mulch is imperative for success. Proper preparation of the soil, coupled with such treatment, will do much to obviate the necessity of watering.

Watering should not be begun until it is absolutely necessary in order to prevent the plants from suffering. When necessary the applications should be thorough, and in very dry periods at least two or three times a week.

A mulch of thoroughly rotted manure around the plants will alone lessen the effects of drought, and will also prevent too rapid loss of water when it is applied.

Dispodding.— In order to have fine flowers and a long succession of bloom, it is infinitely more necessary to keep the seed pods rigorously picked off than it is to cultivate, mulch, or water. The latter operations go for naught unless the pods are picked off. The writer thoroughly believes that the importance of watering has been overemphasized and that too many amateurs prefer to use the hose rather than to pick pods; then they assert that the sweet pea is not what it used to be, that it has lost constitution, and the like. Of course, the more highly developed the variety, the less certain it is to bear up under neglect. There were on the trial grounds at this station in 1910 some of the oldest varieties, introduced from 1865 to 1890, then the latest hooded and grandifloras, and finally the waved type. Although no pods were picked from the first two types after July 20, there was a noticeable difference in the flowering habit. The old varieties were continuously blooming profusely, while the second class were sometimes completely destitute of flowers.

The same holds true with regard to length of stem. Some plants of Countess Spencer were treated likewise in order to note the effect, and for them the season was over early in August.

The lesson is that if the grower does not intend to comply with the requirements of the improved types, it is better to grow Butterfly, Captain Clarke, Peach Blossom, and other small-flowered, precocious varieties.

Fertilizers.— After sweet peas are in full flower, fertilizers may be applied. The best and safest fertilizer to use is liquid manure, diluted to the color of weak tea and applied once a week. It is often advantageous to alternate this with sulfate of ammonia or nitrate of soda at the rate of one ounce to six gallons of water. The plant responds better usually to phosphorus than to nitrogen, and even potash is often beneficial. Nitrate of potash and phosphate of potash dissolved at the same rate as the above-named fertilizers, is of the proper strength to apply.

Summary

The following quotation from George Stanton is a concise summary of sweet pea culture:

" Sweet Pea Culture, condensed.— 12 words. Trench deeply; manure liberally; plant thinly; stake quickly; water freely; dispod promptly."

INSECTS AND DISEASES

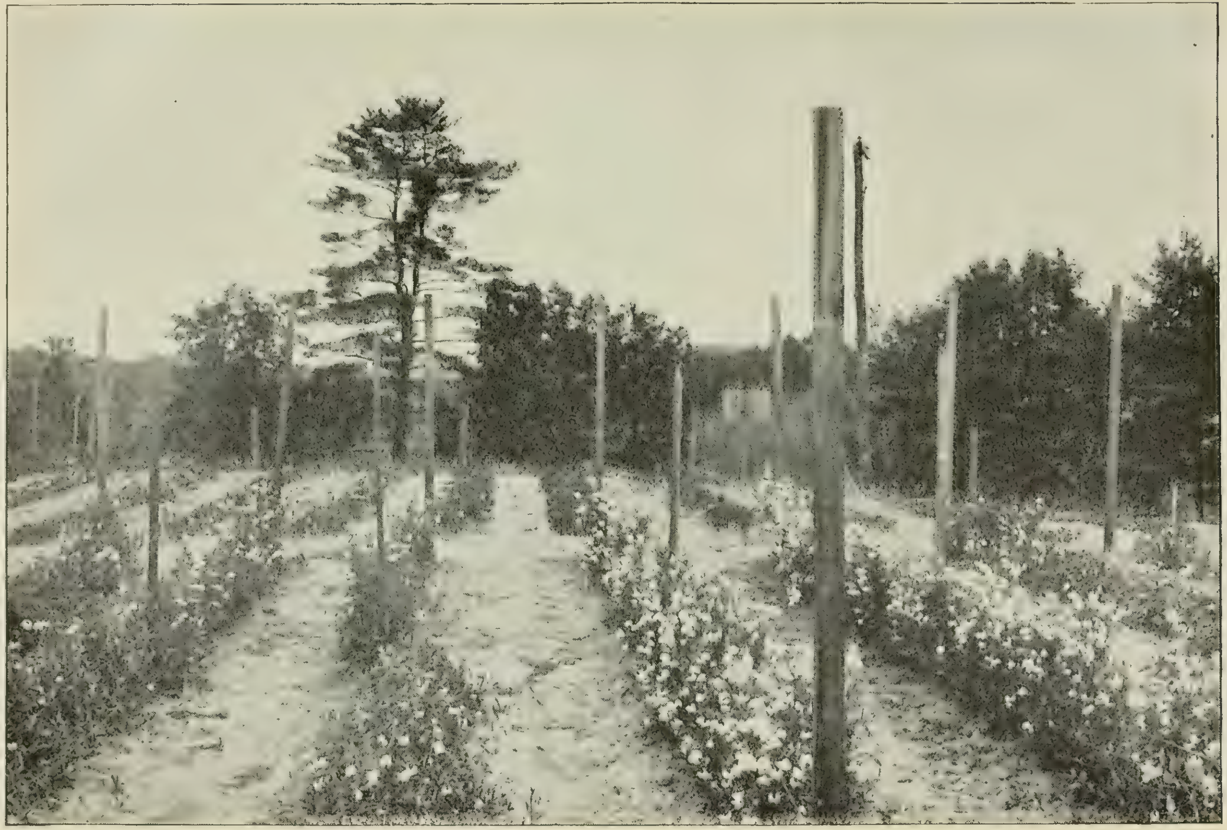
Insects

The most troublesome insects that attack sweet peas in the United States are the red spider and the green plant louse.

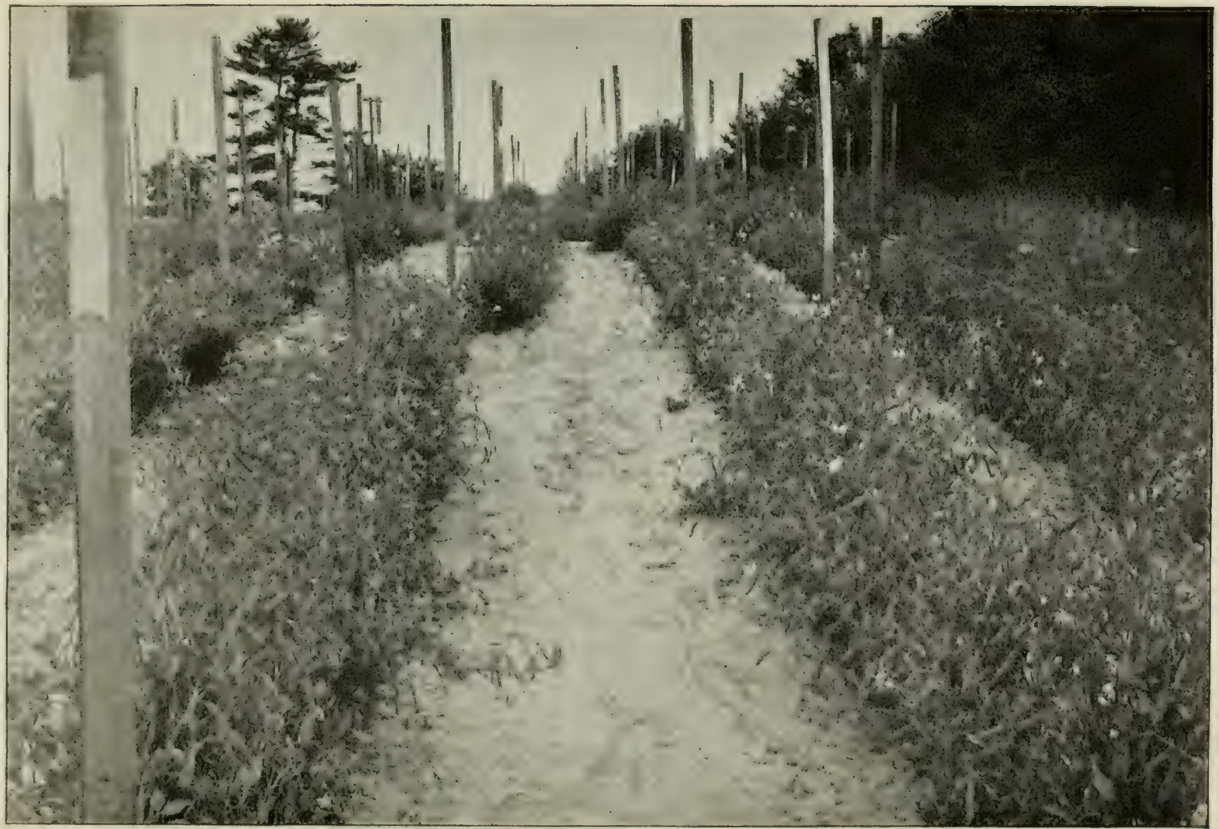
The red spiders attack plants during hot, dry periods, when they are to be found on the underside of the leaves. Usually they are not noticed until they have become sufficiently abundant to cause considerable damage. The experienced grower recognizes the favorable conditions for this insect and begins syringing the plants in the evening, applying the water with hose or spray pump so as to wet the lower surface of all the leaves. This treatment will prevent serious attacks of the red spider.

The green fly, or green plant louse, while often present under other climatic conditions, causes greater injury during weather favorable to the red spider than at other times. This insect may be killed by the use of tobacco extracts, dilute kerosene emulsion, or soap solution. Dusting the plants with tobacco is sometimes practiced.

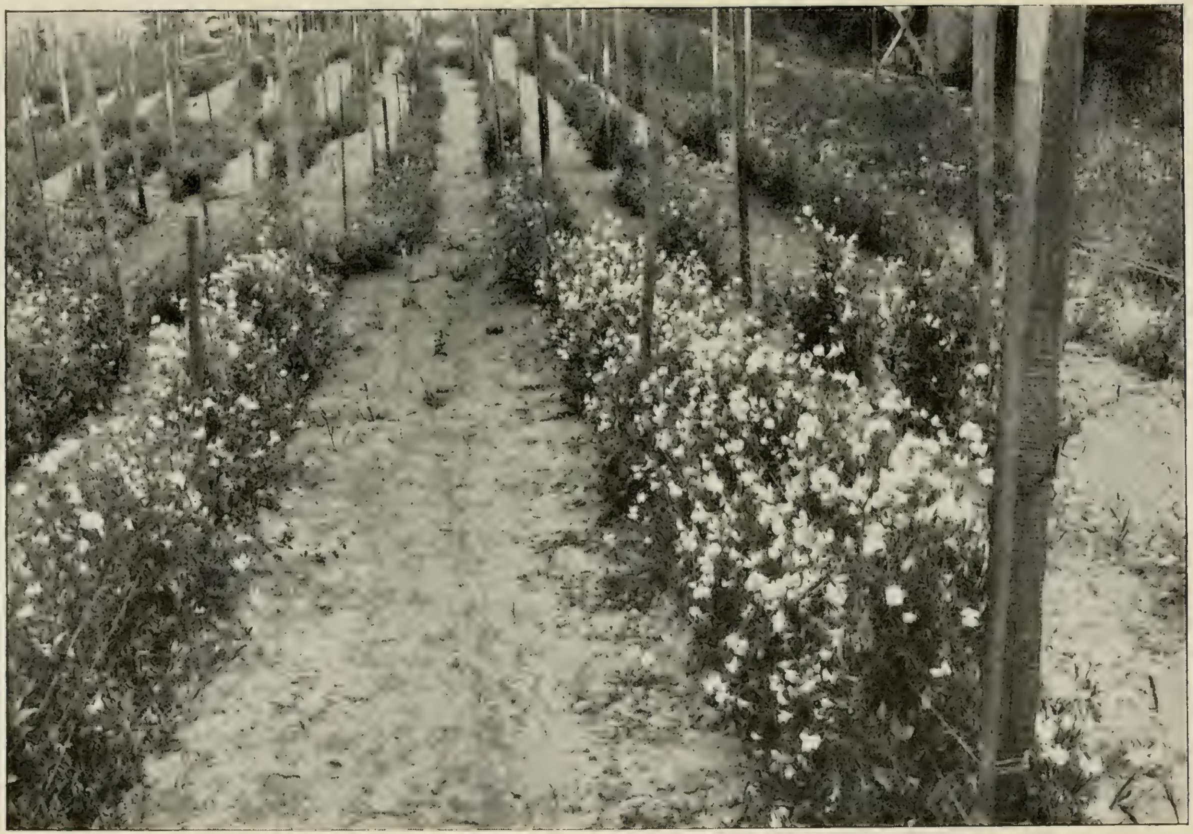
Nematodes, or eelworms, do not attack sweet peas planted outdoors unless infested soil from the greenhouse is used around the plants. When sowing seeds in pots under glass, the proper soil is that which has been sterilized or thoroughly frozen.



Pods not removed *Pods removed*



Shasta, August 23, 1910. Pods allowed to develop



White Spencer sweet peas, August 23, 1910, showing effect of pod removal

The cutworm.— In some seasons the cutworm is very destructive. The preparation of the soil in autumn, with the winter freezing, tends to eliminate this pest. The use of trap plants, such as lettuce, sown alongside of sweet pea rows has been suggested. Poisoned baits can sometimes be used, but not so safely, so far as other animal life is concerned, as in the greenhouse. The larva should be hunted down in its hiding place and destroyed. An application of soot, air-slaked lime, or tobacco dust has some value as a repellent.

Diseases

Powdery mildew.— Among the fungous diseases that attack sweet peas, the powdery mildew (*Erysiphe Polygoni* DC.) is often found late in the season, when the plants are almost through blooming. Sometimes the disease appears earlier. In 1910 it appeared in August and proved very serious on some varieties. The stems, leaves, and other parts of the plant become covered with a white, powdery coating of the mycelium and summer spores. The disease may appear after a rain followed by very cool nights and hot days. Spraying with potassium sulfid, or dusting the plants with sulfur or with a mixture of lime and sulfur — two parts of the former to one of the latter — will control the disease.

Pea spot (*Ascophyta pisi*) is a parasitic fungus attacking sweet peas in England, and, while the writer does not know of its occurrence on sweet peas in this country, the fact that it is known to attack garden peas here is sufficient indication of danger. The disease causes round or angular spots on the leaves and pods. The spots are one fourth inch or less in diameter, usually with a narrow, but distinct, purple border. The use of potassium sulfid or dilute bordeaux mixture is recommended.

Other diseases attacking sweet peas in England are pea blight (*Peronospora trifoliorum*), root rot (*Thielavia basicola*), and streak (apparently a physiological trouble).

EXHIBITING SWEET PEAS

The foundation for success in raising sweet peas for exhibition is laid the previous autumn in the thorough preparation of the soil, followed by a careful selection of varieties, thin planting, and very liberal culture. In order that good flowers may be obtained for exhibition, it is best to remove all flowers about a week before the exhibition date, and to allow only the spikes with the longest stems to develop. The size of the flowers may be increased at this time by the use of ammonia or nitrate of soda.

All varieties subject to scorch or scald should be shaded with cheesecloth or tiffany. If such varieties are planted together the shading may be more easily accomplished. The varieties having orange in their coloration — that is, Henry Eckford, St. George, and Helen Lewis — the salmon varieties, and possibly some of the scarlets and blues, should be shaded for four to six days previous to the time the flowers will be needed. The shade should be so arranged that it can be removed at night.

The sweet peas having been well grown, with stems twelve to fifteen inches long, the next consideration is the cutting of the flowers; for it is one thing to grow good flowers, and quite another, but equally difficult, to exhibit successfully.

Sweet pea flowers, especially for exhibition, should be cut while dry, preferably in the morning or evening. The proper stage of development will depend on the number of hours that must elapse before the judge can pass upon the exhibit. Flowers cut the day before exhibiting should be taken with the lower flowers open and the top one in bud. Those with four flowers on a spike may be taken with the two lower flowers open, the third flower opening, and the topmost one in the bud. The flowers should be placed immediately in cool, hard water and left in a cool, dark room or cellar until they are packed. Here they are left until the latest moment consistent with their timely arrival at the exhibition hall, not more than six or seven hours if possible.

When packing, the stems should be squeezed in order to remove surplus water and then wrapped in a strip of oiled paper. Great care should be exercised not to get water on the flowers. Each bunch should be wrapped in tissue paper and the bunches packed firmly, but not so tightly as to crush the flowers.

Everything possible should be done to insure the prompt arrival of the flowers at the exhibition hall, when they should be unpacked without delay. The flowers should be loosely arranged so that they may resume their natural form after the journey.

The flowers having been put in water, the work of arranging the exhibition vases should begin. George W. Kerr, an experienced exhibitor, gives the following on the arrangement of the flowers:

" In staging the flowers never crowd them. Let every flower ' speak for itself.' Twenty sprays make a nice vase, and the best method of arranging them is to start by putting some grass (cut two inches long) in the mouth of the vase, as this helps to keep the stems in position. Each stem must be put in separately. Let every flower be seen as far as possible and all face one way, with the exception of such varieties as have the back of the standards tinted in coloring other than the ground color of the flower, when the position of such might be judiciously varied. One or two pieces of foliage — a little Gysophila — or light grass, such as Agrostis neublosa, might with advantage be used. But this should not be overdone, and only if the rules allow of it.

"In staging a collection of twelve varieties, they should be stood in three rows, the back rows being tiered eight or nine inches above the other, and arrange the colors so that they do not clash. Even if the show schedule does not ask for it, name each variety with a neat card placed at the base of each vase."

Two very important points for the exhibitor to observe are: (1) follow the rules as to the number of stems per vase and foliage allowed; (2) see to it that the flowers are true to name. Varieties of distinct colors should be used and those that are very nearly like others in the exhibit excluded. Finally, in placing the vases, it is important not to lose sight of the fact that a good color scheme is a great aid to success.

30

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7 The relation of lime to soil improvement
8 The elm leaf-beetle
9 Orange hawkweed or paint brush
11 Helps for the dairy butter-maker
12 The chemical analysis of soil
(Department of Animal Husbandry) The formation of cow testing associations

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CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Soil Technology

THE CHEMICAL ANALYSIS OF SOIL

E. O. FIPPIN

The large number of requests for analyses of samples of soils sent by residents of the State, has made it advisable to put in printed form a statement of the policy of the College in this matter. There appears to be a general belief on the part of persons not familiar with the technic of soil investigation, that a chemical analysis of a soil is in itself a reliable guide to the fertilizer needs of that soil, to the kind of crops adapted to the soil, and to its treatment generally. Unfortunately this is not the case. *It is our policy, therefore, not to make chemical analyses of samples collected by other than our own agents.*

The insufficiency of a chemical analysis of the soil when unaccompanied by other careful studies, the unreliability of samples collected by persons not trained in the work, and the limited facilities of the College, make the analysis of miscellaneous soil samples an unprofitable expenditure of public money.

THE INSUFFICIENCY OF CHEMICAL ANALYSIS

1. *Chemical composition of soils and plants.*—Chemical analysis will determine the total constituents, or some proportional amount of them, which a soil contains. The total amount of plant food constituents in the normal soil is large in comparison with the amount removed by an average crop. Plants use ten elements in their growth and seven of them are obtained from the soil; the soil elements are iron, sulfur, magnesium, calcium, potassium, phosphorus, and nitrogen. Water and the carbon dioxid of the air furnish the other three elements — hydrogen, oxygen, and carbon.

Potassium, phosphorus, and nitrogen have been termed the fertilizer constituents because the addition of these most generally serves to give increased crop growth. The object of a chemical analysis of samples of soil is to determine whether any of these are present in insufficient amounts. The following table shows the amount of the most important plant food constituents in a normal soil in pounds per acre of soil one foot deep:

TABLE 1. COMPOSITION OF SOIL

	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium
Normal soil	6,000	1,600	30,000	24,000	15,000

The quantities of the same constituents used by some of the common crops are shown in Table 2; they appear small in comparison with the amounts given in the first table:

TABLE 2. COMPOSITION OF CROPS

	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium
Corn grain, 50 bushels	50.	8.5	9.5	1.	3.
Corn stover, 1.5 tons	24.	3.0	26.	10.	5.
Wheat grain, 25 bushels	35.5	6.	6.5	1.	2.
Wheat straw, 1.75 tons	12.5	2.	22.5	7.	3.
Clover hay, 2 tons	80.	10.	60.	45.	17.
Potatoes, 150 bushels	32.	6.5	45.	2.	3.
Apples, 300 bushels	24.	2.5	28.5	1.	2.
Apple leaves, 2 tons	30.	3.5	27.	50.	13.

The elements in the soil are chemically combined in the mineral particles and in the organic matter, and only a small proportion is in the soluble or available form at any one time. A chemical analysis can determine the total amount of any particular constituent present, but this or any other laboratory determination cannot indicate what part of this total is available to plants as the soil lies in the field.

2. *Very little relation between chemical analysis and fertilizer response.*—Experience covering many years and on a great variety of soils has shown that a laboratory determination of the availability of a soil is not often a reliable guide to the kind of fertilizer to which crops respond on that soil in the field. The deficiencies of certain constituents such as nitrogen and lime are frequently indicated by the physical characteristics of the soil. The absolute deficiency of other constituents is rare and does not warrant the College in making a chemical analysis to settle this point.

3. *Other factors.*—Several other factors may have much more influence on the productiveness of the soil than does the amount of plant food contained. The moisture supply may be poorly regulated; there may be too much or too little at certain seasons. Lime may be needed to sweeten the land, organic matter may be deficient, the tilth may be bad, all of which factors determine the availability to the crop of the food in the soil; and these should first be adjusted so far as possible. This is necessary even when fertilizers are used.

UNRELIABILITY OF SAMPLES

1. A very small amount of soil, only a fraction of an ounce, is used in chemical analysis. It is therefore of the greatest importance that samples for analysis be taken with the very greatest care in order that they fairly represent the field or farm. *Samples taken by an inexperienced person are very unlikely to be fairly representative.*

2. Samples for analysis should be taken by a person who is experienced in collecting such material and who knows the physical characteristics of the land. The geology of the region, the physical characters of the soil, the topography, the vegetation, the drainage conditions, and the past treatment with respect to crops, tillage, and manures, all determine the reliability of samples.

THE LIMITED FACILITIES OF THE COLLEGE LABORATORIES

1. The cost of making a chemical analysis of a soil is large in time, in materials, and in equipment. To make a complete analysis requires a highly trained chemist working for about ten days. A complete determination on one sample alone will therefore cost $20 to $50, according to the number run at one time.

2. The funds of the College for this purpose are very much limited, owing to the many other lines of work that are being conducted.

3. Such funds as are available for the analysis of soils are believed to be best expended in systematic investigation of the chemical characteristics of samples of soil carefully selected by our agents, so that they are fairly representative of large areas, in order that the results may be of the widest application. The supplementary data are collected in the same careful manner. This investigation of the chemical character of the soil is part of a general investigation now in progress, of the properties and the methods of handling the soils of the State.

Suggestions.— In considering the improvement of any piece of land, *the following factors should receive attention and must be properly adjusted* before either the natural store of food in the soil or the food added in fertilizers is most readily available to crops:

(a) *The moisture supply.*— On a large part of the land in New York this means some drainage — underdrainage by means of tile. It generally means careful surface tillage to hold and conserve moisture, and on very light gravelly soil it may mean irrigation.

(b) *Lime.*— For the majority of crops, and especially for the common legumes (clover and alfalfa), a sweet soil is necessary. Lime is used to bring about this condition and is most likely to be needed on land long cultivated. When clover and blue grass do not thrive, while sorrel and daisy are common, there is strong evidence of the need of lime.

(c) *A good supply of decayed organic matter, humus*, indicated by a dark color, is essential to the normal New York soil. Stable manure and green manures give this condition.

(d) *Deep, careful plowing, thorough, clean, level tillage, and the use of the dust mulch on hoed crops* are essential. Where these conditions are fully met the use of fertilizers is minimized and often rendered unnecessary.

The *only reliable method to determine the fertilizer* needs of a soil is by *field plot tests*, using different materials in different combinations over several years.

The following books will be found to contain much useful information for the average farmer, on the character and composition of soils, fertilizers, and manures, and on the handling of the land:

The Soil. S. W. Fletcher. Doubleday, Page & Co. $2.00.
Soil Fertility and Permanent Agriculture C. G. Hopkins. Ginn & Co. $2.25.
First Principles of Soil Fertility. Alfred Vivian. Orange Judd Company. $1.00.

INDEX

A

PAGE

Accountant, public, letter from, liv
Acting President's report, ix
Adametz, Leopold, 416, 417
Adams Act, xiv, lxvii, xc
Agents, county, clxix
Agricultural Chemistry, report of Department of, cxxxvii
Agricultural surveys, lv
Alefield, Mr., 665
Alfalfa, experiments with, lxvii
Alfalfa seed, effect of sulfuric acid treatment on germination, 317
Alfalfa, top-dressing, xciii
Alternaria blight of ginseng, lxxxiii
American Florist, The, 622
American Gladiolus Society, ci, cii
American Peony Society, c, cii, 53, 56
American Sweet Pea Society, ci, cii
Animal Husbandry, report of Department of, cxxi
Announcer of the College of Agriculture, xv
Ansley, Marcus, 170
Anthracnose of the bean, lxxxii
Anthracnose of the raspberry, lxxxv
"Apoplexy" in winter-fed lambs, the cause of, 33
Apple diseases, lxxxiii, lxxxiv, lxxxv
Apple orchard survey of Ontario county, an, 161
Apple scab, use of sulfur against, lxxxiii
Apple-tree canker, lxxxiv
Apples, value of selected scions, cvi
Arboretum, cxli
Archips argyrospila, 279
Archips cerasivorana, 290
Archips rosaceana, 289
Arkwright, Edwyn, 624, 632, 633
Armour & Company, 5
Ascomycetes, species of, 470
Ascophyta pisi, 711
Aster diseases, lxxxiv
Ayres, Bryson, Company, 632
Ayres, H. L., cxvii, cxix

B

PAGE

Babcock test clxxviii
Bacteria of legume nodules .... lxxviii, lxxix, 260
Bailey, L. H. .... li, liv, clxxii
Bailey, Director L. H., report x
Baker, W. C. cxliv
Baker, W. C., report cxliii
Banks, Sir Joseph 60, 62, 63, 64, 67
Barger, W. E. cvi
Barrus, M. F. .... lxxxii, lxxxviii
Barry, P. 280, 282
Barwell, J. W. 18
Barwell Mills 6
Batchelor, L. D. 49, 53
Bauhinus, J. 685
Beach, S. A. 184
Beal, A. C. .... civ, 617, 657
Beal, A. C., report xcix
Beale, Gilbert 684
Bean diseases lxxxii
Beans, soy, as a supplementary silage crop 257
Beckwith, T. D. 424
Benary, Ernest 626, 697
Bentham, Mr. 662
Bibliography of facultative parasites 438
Bibliography of the fruit-tree leaf-roller 291
Bibliography of statistical methods 214
Bibliography of sulfuric acid treatment for germination of seeds 336
Black-canker of peaches lxxxv
Black-rot of grapes lxxxii
Black-rot of violets lxxxv
Blossom blight lxxxv
Bocconi, Paolo 682
Boddington, A. T. 632, 633
Boerhaave, Mr. 680, 681
Boiler, steam, for lime-sulfur cxxxiv
Bolley, H. L. 297, 298
Botrytis blight lxxxv
Braucher, R. W. 279, 282, 284, 285, 286, 287
Breck, Joseph 689, 691, 692
Brome grass as forage plants, tests of lxvii
Brown, E. 296
Brown, Steven 688
Brown Brothers Nursery lxxxii
Buckman, H. O. xc
Bud variation, studies on lxx
Buildings, additional, need for xii
Bull, W. 689
Bulletin 304 1

PAGE
Bulletin 305 33
Bulletin 306 49
Bulletin 307 161
Bulletin 308 217
Bulletin 309 cxxii, 229
Bulletin 310 257
Bulletin 311 277
Bulletin 312 293
Bulletin 313 337
Bulletin 314 393
Bulletin 315 lxxxiii, 413
Bulletin 316 clv, 505
Bulletin 317 clxxi, 545
Bulletin 318 cxxvii, 569
Bulletin 319 ci, 617
Bulletin 320 ci, 657
Burmann, Mr. 626, 681, 683, 684
Burpee, W. A. 625, 626, 684, 690, 692, 693, 697, 698
Burpee, W. A., & Co. 691, 692
Burrell, Edward 169
Busse, W. 425
Butler, E. J. 420
Butler, W. B. liv
Butter, metallic flavor in cxviii
Butter, moisture and salt in cxviii
Butter-fat production, cost of cxxiii
Butter-fat, testing cream for cxviii
Byron Fruit Growers' Association lxxxiv

C

Calcium, effect of, on soil xciii
Calcium, removal of, from soils xci
Calves, substitutes for skimmed milk in raising 1
Canker diseases lxxxiv, lxxxv
Carnation diseases lxxxiv
Carr, M. E. xcv
Carrots for live-stock, culture of 564
Carrots for live-stock, experiments with 549
Carter, J., & Co. 687, 688
Casteels, Peter 684
Cause of "apoplexy" in winter-fed lambs, the 33
Cauthen, E. T. 325
Cavanaugh, G. W. cxxxviii, 265
Cavanaugh, G. W., report cxxxvii
Cement tile investigations cxxxv
Cereal-breeding experiments lxiii, lxxi
Chapman, Mr. 169
Cheese, cheddar, factors determining yield cxviii

PAGE
Chemical analysis of soil, the........Cir. No. 12 (following Bulletin 320)
Chemistry, Department of. See Agricultural Chemistry.
Chestnut-bark disease........ lxxxiv
Chestnut oak, twig blight of........ lxxxiv
Circular No. 12........Following Bulletin 320
Clark, C. F........337, 339, 340
Clark, Trevor........687, 688
Classification of mailing list........ clxxi
Classification of the peony........ 49
Clover seed, effect of sulfuric acid treatment on germination........ 299
Coker, E. T........296, 325, 334
Cold-storage facilities, need for........lxxvi, lxxx, lxxxix, civ, cvii, cxx
College farm, activities on........ lviii
Colts, cost of raising........ cxxii
Commelin, Caspar........678, 679, 681
Comstock, J. H........ cxv
Comstock, J. H., report........ cxi
Conn, H. J........ 430
Constitutional vigor in poultry........cxxvii, 569
Contests, agricultural........ clxxv
Continuous cropping, effect of, on soil........ xciii
Conventions and conferences, Farmers' Week........ xxxiii
Cook, L. B........ cxvii
Cooling milk, methods of........ cxviii
Cooper, Taber & Co........685, 687
Cooperative tests of corn varieties........ 393
Cooperative work with farmers........lxx, cxiv, 268, 393, 554
Corn-breeding experiments........lxii, lxxi
Corn Day........ clxxv
Corn, silage, value of........ 547
Corn varieties, cooperative tests of........ 393
Cornell Dairy Students' Association........ xxxvi
Cornell Reading-Course Lessons for the Farm........cxix, clxx, clxxii
Cornell Rural School Leaflets........ clxxvi
Cornell study clubs........cxlix, cli, clxxii
Correlation of characters in plants........ lxix
Correspondence, amount of........xlix, lviii, lxxxvii, xcvi, cxxvii, clxx, clxxvii
Cost-accounting work on farms........ lv
Cotton seed, effect of sulfuric acid treatment on germination........ 321
Cotton and Truck Disease and Sugar-Plant Investigations, Department of. lxxxiii
County agents........clxix, clxxii
Courses of Instruction........ clxxxi
Cow-testing........ cxvii
Cowpeas, experiments with........ lxvii
Cows, cost of raising........ cxxiii
Cox, Professor........511, 517, 518, 522, 523
Cox, H. R........ cii

PAGE

Crabb, G. A. xcv
Craig, John .... l, xcix, cii, 53, 55, 56, 161, 164, 165, 659
Crane, T. F. ix
Crane, Acting President T. F., report ix
Cream separators, hand, variation of cream cxviii
Crop Reporter, The 395
Crosby, C. R. .... lxxxiii, cxiv, 217
Crown-gall disease lxxxv
Culture of root crops, the 559
Culture of the sweet pea .... ci, 627, 657
Cumulative action of selection in plants, studies on lxix
Cupani, P. F. Franciscus 678, 680, 681, 683, 684
Cutworm 711

D

Dairy business xlvii
Dairy heredity, study in cxxii
Dairy Industry, commercial work of Department of xlvii
Dairy Industry, publications of cxix
Dairy Industry, report of Department of cxvi
Dairy problems, practical cxix
Dairy products, scoring of cxix
Damping-off fungus 631
Dauphin, Joseph 53, 56
Davis, E. G. cxxxix
Dead-arm disease of grapes lxxxii
Dean, A. D. clxxvi
Dean, H. H. 6, 7
Derostenus salutaris 223
Deutsche Gartner-Zeitung 622
Dicks, S. B. 682
Dipnall, T. H. 696
Director's report x
Distribution of new varieties of plants .... lxx, lxxii
Douglas, James 697
Downy mildew lxxxii
Drain tile investigations cxxxv
Drainage, farm .... xcv, xcviii, cxxxiv
Drainage surveys xcv
Drainometer cxxxiv
Drawing, report of Department of cxliii
Drinkard, A. W. lxviii
Du Bois, C. O. 401
Duggar, B. M. .... l, lxxvii, lxxviii
Duggar, J. F. 325
Dwarf sweet peas 697
Dyar, H. G. 285

E PAGE

Eastman prize in public speaking... clvi
Eckford, Henry... 688, 689, 690, 691, 697, 708
Editorial work, summary report of... xv
Eelworms... 710
Egg-production, record of highest... xlv, cxxxi
Egg-production, studies in... cxxvi
Eggs, chemical changes in... cxxxvii
Ellwanger & Barry... 67
Engelmann, C... 624, 632
Engineering, farm... cxxxiv, cxxxv
Entomology, publications of Department of... cxi
Entomology, report of Department of... cxi
Erysiphe Polygoni... 711
Eugenics Club of Cornell University... lx
Evans, R. J... lxviii
Ewes, development of early breeding habit of... cxxi, cxxii
Expenditures, Experiment Station... liii
Expenditures, extension work... liii
Expenditures, State College of Agriculture... lii
Experiment station expenditures... liii
Experiment station staff... viii
Experiment station work... xiv
Experimenters' League... xxxiv, clxviii, clxxii
Extension Department, report of... clvi
Extension Teaching Department, need for... xiii
Extension work... xii, lv, lvii, lxx, lxxix, lxxxvi, xciv, cii, cvi, cx, cxiii, cxix, cxxiii, cxxvii, cxxxv, cxl, cxlv, cxlviii, clv, clvi, clxxiv
Extension work expenditures... liii

F

Faculty, list of members... v
Faculty, need for increase... xii
Farm, college. See College farm.
Farm Crops, Department of, united with Farm Practice... lvii
Farm engineering... cxxxiv, cxxxv
Farm Management, report of Department of... lv
Farm Mechanics, report of Department of... cxxxiii
Farm Practice and Farm Crops, report of Department of... lvii
Farm trains... clxv
Farmers' Week... xvi, lxxiv, lxxix, lxxxvi, cii, cxlix, clvi, clxiii, clxxviii, 396
Farmers' Week program... xvi
Farr, B. H... 53, 56, 58, 60, 61
Faulwetter, R. C... lxxxiv
Felt, E. P... 281
Fernald, C. H... 281
Ferry, D. M., & Co... 625, 691, 692
Fertilizers... xciv, cii
Fertilizing for hay crops... xcii

PAGE
Financial statement lii
Fippin, E. O. .... 190, and Cir. No. 12
Fire blight lxxxiii
Fitzpatrick, H. M. lxxxiv
Fleming, Bryant cxlii
Fleming, Bryant, report cxxxix
Fletcher, Mr. 289
Fletcher, A. G. lxxxvi
Fletcher, H. 684
Foliage diseases .... lxxxiii, lxxxv
Forage crop investigations lxvii
Forest-tree diseases lxxxiv
Forestry, report of Department of cviii
Frank, A. B. 426
Frasch, Herman .... lxxxiii, lxxxiv
Fraser, Samuel 337, 339
Fritsch, Karl 665
Frost, J. N. 46
Frost cankers lxxxv
Frosts in New York .... clv, 505
Fruit diseases lxxxiv
Fruit, evaporated, moisture and sulfur content cxxxvii
Fruit, variety tests of cvi
Fruit-tree diseases .... lxxxiv, lxxxv
Fruit-tree leaf-roller, the 277
Fungi .... lxxxiii, 413
Fungi Imperfecti, species of 474
Fungicides .... lxxxiii, lxxxiv, lxxxv
Fungous flora of the potato lxxxiii
Fungous flora of the soil .... lxxxiii, 413
Furber, Robert 684
Further experiments on the economic value of root crops for New York .... clxxi, 545

G

Gerard, Mr. 680
Germination of seed as affected by sulfuric acid treatment 293
Gilbert, A. W. .... lx, lxviii, 340
Gillette, C. P. 280, 282, 283, 284, 285, 287
Gilmore, J. W. 337, 339
Ginseng diseases lxxxiii
Ginzberger, August 665
Gladiolus diseases lxxxiv
Gladiolus studies ci
Glycine hispida 262
Gore, J. G. 527
Gould, Thomas 626
Grape diseases lxxxii

PAGE
Green, Roland 686
Green fly 710
Gregory, C. T. lxxxii
Gunn, David lxxxv

H

Haage & Schmidt 688
Hagen, Oscar 420, 421, 422
Hansen, Timothy 340
Hard-rot disease of gladiolus lxxxiv
Harper, M. W. cxxii, cxxiii
Hartog, John 681
Hatch Act xiv
Hays, W. M. 341
Hayward, Mr. 3, 4, 5, 6
Heaters for orchards 527, 528
Hedrick, Mr. 529
Heifers, cost of raising cxxiii
Henderson, Peter, & Co 625
Henry, W. A. 260
Herd's grass 340
Heredity in cows, study in cxxii
Herrick, G. W cxiv, 277
Hesler, L. R. lxxxiv
Hill, Mr lxxviii
Hiltner, L. 425
Home Economics, report of Department of cxlvii
Homemakers' Conference xxxiv
Hooker, Mr. 225, 662
Hooker, C. M. 227
Hooker, C. M., & Sons 219, 220, 227
Hop mildew lxxxiii
Hopkins, A. D. 341
Hopper, H. A. cxxiii
Horses, cost of producing cxxii
Horses, draft, comparison of rations for cxxiii
Horses, farm, improving cxxiii
Horses, work, comparison of oats with corn and oats for cxxii
Horticulture, report of Department of xcix
Hottes, C. F. 296
Howard, Professor 513
Hueppe, Mr. 417
Hunt, T. F. 337, 339
Hutchins, W. T. 689, 691, 692, 702
Hyphomycetes, key to 475

I

Ignatiev, G. M. cii
Inheritance in plants, studies on the laws of lxviii

PAGE
Insect pests ....lxxxiv, 217, 277, 630, 710
Interlaken Elgin Creamery Company.......... xlviii
Irrigation experiments ....cvi, cxxxiv

J

Jackson, Mr. 285, 289, 290
Jackson & Perkins.. lxxxii
Jagger, I. C. lxxxiii
Jehle, R. A. lxxxv
Jensen, C. N. ....lxxxiii, 413
Johnston, John 190
Justice, James 685

K

Kearfott, W. D. 220
Keats, John 678
Kerr, G. W. 712
Knight, Harry 279
Knight Law, experiments to test................................ lxviii
Kniphof, Mr. 682, 683
Knudson, Lewis lxxx
Knudson, Lewis, report... lxxvii
Koning, C. J. 418, 419
Krüger, F. 425

L

Ladd, Mr. lv
Lambs, "hothouse," the production of............................cxxii, 229
Lambs, winter, cost of production of............................cxxii, 229
Lambs, winter-fed, the cause of "apoplexy" in..................... 33
Lathyrus 624, 659, 661
Lauman, G. N. cxlvi
Lauman, G. N., report.. cxlv
Lawns, making and care of.. cxli
Laxton, Thomas 688
Laxton Brothers 698
Leaf-curl disease of peaches..................................... lxxxv
Leaf-miner, the plum.. 217
Leaf-roller, the fruit-tree....................................... 277
Legume nodules, bacteria of...........................lxxviii, lxxix, 260
Leighty, C. E. 293
Lendner, Alfred 420, 422, 423, 438
Letters, children's clxxviii
Lettuce diseases lxxxiv
Limestone, ground, effect on soil................................ xciii
Lime-sulfur, steam boiler for.................................... cxxxiv
Lindsey, J. B. 5, 6, 18
Linnæus, Carolus 681, 682, 684

PAGE
Lintner, J. A. 279, 280, 282, 289
Literature. See Bibliography.
Livermore, K. C. lv
Live-stock at the College xlii
London, Mrs. 687
Love, H. H. lxviii, 165, 293, 340
Lugger, Otto 289
Lynch, Mr. 692
Lynch, J. H. 9
Lyon, T. L. xcviii
Lyon, T. L., report xc
Lyon, W. S. 573

M

McCloskey, Alice G. clxxviii, clxxx
McCloskey, Alice G., report clxxiv
McCool, Doctor lxxviii
McDowell, Silas 514
McInerney, T. J. cxvii
McKay, A. W. 163, 170
McMahon, Professor 165
McPhee, Erastus 403
Mailing list, classification of clxxi
Malcolm, W. 685
Manganese, effect on plants lxxviii
Mangels for live-stock, culture of 559
Mangels for live-stock, value of 547
Manns, T. F. 423, 426
Marketing association, egg and poultry, cooperative cxxviii
Marketing "hothouse" lambs 236
Martin, Professor cxxxix
Martin, H. M. 161, 163, 165
Martyn, Mr. 686, 693
Mason, John 685, 687
Massachusetts Horticultural Society 122
Massey, L. M. lxxxiv
Maxon, E. T. xcv
Mekeel's creameries xlviii
Merrill-Soule Company 18
Metallic flavor in butter cxviii
Meteorology, report of Department of cliv
Middaugh, H. W. cxvii
Middleton, Lord 684
Mildew, downy lxxxii
Mildew of ginseng lxxxiii
Mildew of hop lxxxiii
Mildew, powdery 711
Mildew of sweet peas 631, 711
Milham, W. I. 523

PAGE
Milk inspection cxvii
Milk, methods of cooling cxviii
Milk production, cost of cxxiii
Miller, Philip 682
Minns, E. R. 257, 393, 545
Montgomery, E. G. l, lvii
Morris, R. T. ciii
Morrison, T. M. xcv
Morse, Mr. 691, 693, 698
Morse, C. C., & Co 659, 692, 697
Muck lands, vegetable experiments on ci
Mucorales, key to 443
Mulford, Walter cx
Mulford, Walter, report cviii
Mutations in plants and their use in breeding, studies on lxix
Myers, C. H. lxviii

N

Namyslowski, B. 420, 423
National Horticultural Society of France 697
National Nutrient Company 4
National Sweet Pea Society 659, 694
Nematodes 710
Nepticula plagicolella 224
Nepticula slingerlandella 219, 220
New York Florists' Club 622
New York Plant Breeders' Association xxxvi
New York State Conservation Commission lxxxiv
New York State Drainage Association xxxiii
New York State Federation of Floral Clubs cii
New York State Fruit Growers' Association lxxxvi, lxxxvii, 219, 226
New York State Ginseng Growers' Association lxxxiii, lxxxvi, lxxxvii
New York State Vegetable Growers' Association xxxviii, cii
Nicoll, A. J. 399
Nikitinsky, J. 417, 418
Nitrogen balance in soils xciv
Noble, Cooper & Bolton 687
Northern Nut Growers' Association ciii
Norton, J. B. lxiii
Nursery diseases lxxxii, lxxxiv
Nuts, Morris collection of ciii

O

Oak, chestnut, twig blight of lxxxiv
Oat-breeding experiments lxiii, lxxi
Oblique-banded leaf-roller, the 289
Office of Drainage Investigations, United States xcvi
O'Gara, Mr. 522, 530

PAGE
Onion blight lxxxiv
Onion smut lxxxiv
Orchard heaters 527, 528
Orchard survey, apple, Ontario county 161
Oriental pears, study of cii
Oudemans, C. A. J. A 418, 419

P

Packard, A. S 280, 281, 282, 283
Page, Mr. 686
Page, W. O 279
Parasites of fruit-tree leaf-roller 286
Parasites of plum leaf-miner 222
Park, J. B 295
Parkinson, Mr. 680
Parrott, P. J 226
Paul, F. F 632, 633
Pea spot 711
Peach, as affected by irrigation cvi
Peach diseases lxxxv
Pears, Oriental, study of cii
Pearson, Karl 208, 209
Peony, classification of the 49
Peony diseases lxxxv
Peony studies .... c, 49
Peppers, study on laws of inheritance in lxix
Peters, L. 425
Petiver, Mr. 680
Phleum pratense 340
Phycomycetes, species of 443
Pickerill, H. M cxvii
Piper, Mr. 289
Piper, A. V 666
Plant-Breeding, publications of Department of .... lx, lxxv
Plant-Breeding, report of Department of lix
Plant lice, green 710
Plant Pathology, report of Department of lxxxi
Plant Physiology, report of Department of lxxvii
Plukenet, Leonard 679, 680
Plum leaf-miner, the 217
Pomology, report of Department of cv
Pork production, relation of breed and individuality in cxxii
Potato-breeding experiments .... lxvii, lxxi
Potato, fungous flora of the lxxxiii
Potato scab, use of sulfur as a fungicide for lxxxiii
Potatoes, studies on bud variation lxx
Poultry at the College .... xliv, cxxxi
Poultry-breeding, studies in cxxvi
Poultry breed-testing project .... xlv, cxxviii

PAGE

Poultry, constitutional vigor in........cxxvii, 569
Poultry farm........xliv
Poultry Husbandry, report of Department of........cxxv
Poultry surveys........cxxviii
Powdery mildew........711
Practical dairy problems........cxix
President's report. See Acting President's report.
Printing and publishing........xv
Production of "hothouse" lambs, the........cxxii, 229
Production of new and improved varieties of timothy, the........337
Prucha, Mr........lxxviii
Public accountant, letter from........liv
Publications of the College........xv, 1
Publications of Department of Dairy Industry........cxix
Publications of Department of Plant-Breeding........lx, lxxv
Publications of Department of Soil Technology........xcvii

Q

Quaker Oats Company........3, 8

R

Rankin, W. H........lxxxiv
Raspberry anthracnose........lxxxv
Ravini, Mr........680
Ray, John........680
Reading-Courses. See Cornell Reading-Course Lessons.
Red-clover seed, effect of sulfuric acid treatment on germination........299
Red spiders........710
Reddick, Donald........lxxxviii
Reeder, George........514
Registration........x
Registry records, advanced, of pure-bred cows........cxxiii
Reinitzer, F........417
Respiration of fruits........lxxviii
Rhinebeck Violet Growers Mutual Protective Association........lxxxv
Rice, J. E........cxxxii, 569
Rice, J. E., report........cxxv
Riley, C. V........280, 282
Riley, H. W........cxxxvi, 165
Riley, H. W., report........cxxxiii
Rivas, D........423
Robb, B. B........cxxxiv, cxxxv
Roberts, I. P........557
Robinson, C. T........281
Rogers, C. A........569
Rohnert, W. E........698
Root crops, the culture of........559

PAGE
Root crops for New York, further experiments on the economic value of ... clxxi, 545
Root rot of ginseng ... lxxxiii
Root rot of violets ... lxxxv
Rose, Flora ... cliii
Rose, Flora, report ... cxlvii
Rosenbaum, Mr. ... lxxxiii
Rostrup, O. ... 296, 297
Royal Horticultural Society ... 687, 688, 689, 694, 697
Ruppii, H. B. ... 680
Rural Art, report of Department of ... cxxxix
Rural Church Conference ... xxxvii, xl
Rural Economy, report of Department of ... cxlv
Rural Leaders' Training Conference ... xli
Rural School Education, report of Department of ... clxxiv
Rust of ginseng ... lxxxiii
Rust of pine trees ... lxxxiv
Rust of timothy ... 352
Rutabagas for live-stock, culture of ... 565
Rutabagas for live-stock, experiments with ... 549

S

Salisbury, W. A. ... 163, 170
San José scale ... lxxxv
Sanderson, Mr. ... 284, 285, 289, 290
Sankey, Doctor ... 689
Saunders, A. P. ... 56, 58
Savage, E. S. ... cxxiii, 1, 229
Sayers, Edward ... 687, 693
Schneider-Orelli, O. ... 297
Sclerotinia fructigena ... lxxxv
Scoring of dairy products ... cxix
Scotch pine rust ... lxxxiv
Scott, William ... 621
Scribner, H. L. ... lxxxvi
Seed, germination of, as affected by sulfuric acid treatment ... 293
Seeley, D. A. ... 517, 518
Selby, A. D. ... 423
Septic tank ... cxxxiv
Sewage disposal ... cxxxiii, cxxxv
Shepard, C. E. ... 35, 45, 46
Sherard, D. ... 680
Sherard, William ... 681
Sherbakoff, C. D. ... lxxxiii
Silage corn, value of ... 547
Silage, soy beans as a supplementary crop ... 257
Skimmed milk in raising calves, substitutes for ... 1
Slaughtering "hothouse" lambs ... 236
Slingerland, M. V. ... 219, 220, 225, 226

PAGE
Smith, E. F. 432, 433
Smith, E. L. lxxxvi
Smith, L. H. 295
Snook, Miss cxlviii
Snyder, Professor 165
Society of American Florists lxxxv, 622
Soil, the chemical analysis of Cir. No. 12 (following Bulletin 320)
Soil moisture, effect of, on plant nutrients xc
Soil survey xcv, xcviii
Soil Technology, publications of Department of xcvii
Soil Technology, report of Department of xc
Soil types, study of xcii
Soja bean 262
Soy beans as a supplementary silage crop 257
Spencer, J. W. clxii
Sphaeropsidales, key to 474
Sphaeropsis malorum lxxxiv
Spiders, red 710
Spray tower, collapsible cxxxiv
Spraying demonstrations lxxxvi, cxxxv
Sprenger, G. 682
Spruces, seedling, disease of lxxxiv
Squash, hubbard, experiment with fertilizers cii
Stanton, George 710
Statistical methods 208
Stedman, J. M. 280, 282, 283, 284
Stewart, J. H. 220
Stewart, V. B. lxxxii
Stocking, W. A., Jr. cxx
Stocking, W. A., Jr., report cxvi
Stone, J. L. lviii, 266
Stone, J. L., report lvii
Stow, F. W. 513
Stryke, Anna C. 219
Students' Association of the New York State College of Agriculture xxxviii, xl
Study clubs, Cornell cxlix, cli, clxxii
Substitutes for skimmed milk in raising calves 1
Sulfate of iron as a fungicide lxxxv
Sulfur and its compounds as a fungicide lxxxiii
Sulfuric acid treatment, effect of, on germination of seed 293
Sullivan, General 169
Summer School, announcement of courses ccii
Surgical methods for trees lxxxiv
Surveys, agricultural lv
Surveys, drainage xcv
Surveys, orchard 161
Surveys, poultry cxxviii
Surveys, soil xcv, xcviii

PAGE
Sutton & Son, 694
Sweet clover seed, effect of sulfuric acid treatment on germination, 317
Sweet Pea Annual, 624, 706
Sweet pea, culture of the, ci, 627, 657
Sweet pea diseases, 711
Sweet pea studies, ci, 617, 657
Sweet peas, dwarf, 697
Sweet peas, winter-flowering, ci, 617

T

Tailby, G. W., Jr, l, 229
Tallman, Thomas, 169
Teeter, H. W., 339, 340
Theophrastus, 661
Thielavia basicola, lxxxiii, 711
Thom, Charles, 432
Thompson, Mr., lv
Thompson, W. R., 291
Thorburn, Mr., 686
Thornber, J. J., 297
Thurlow, T. C., 68
Timothy-breeding experiments, lxi, lxxii, 337
Timothy contest, lxxiii
Timothy, the production of new and improved varieties of, 337
Todaro, F., 297
Tomatoes, studies of, lxxviii, cii
Top-dressing alfalfa, xciii
Torrey Botanical Club, 662
Townsend, Benjamin, 684
Tracy, W. W., 625
Trains, farm, clxv
Tree diseases, lxxxiv, lxxxv
Trimen, Mr., 684
Truck-crop diseases, lxxxiii
Tuck, C. H., clxxiii
Tuck, C. H., report, clvi
Turnips for live-stock, culture of, 565
Tutt, J. W., 224
Tuttle, E. M., clxxviii
Twig blight of chestnut oak, lxxxiv

U

Ugly-nest leaf-roller, the, 290
Ulrich, P., 425
Union Sulphur Company, lxxxiii
Uvedale, Doctor, 678, 680

V

PAGE

Valsa leucostoma lxxxv
van Iterson, C. J. 417, 418
Van Rensselaer, Martha cliii
Van Rensselaer, Martha, report cxlvii
Van Slyke, Doctor 265
Variation in plants lxviii, 345
Vaughan, J. C. 692
Vegetable-accounting ci
Vegetable Growers' Association of America lxxxvii, xcvi, ciii
Vick's, James, Sons 688, 692
Viereck, H. L. 279
Vinall, H. N. 296, 319
Violet diseases lxxxv
Voorhelm, Dirk 685
Voorhelm, Pierre 685
Voss. See Vossus, Cornelius.
Vossus, Cornelius 681, 684

W

Walker, Mr. 692
Walker, Francis 281
Wallace, Doctor lxxxiv
Walsingham, T. 281
Warne, Frank 402
Warren, G. F. lvi
Warren, G. F., report lv
Water-soluble material in soils xci
Waters, H. J. 377, 378, 379, 380, 381
Watson, Mr. 665
Webber, H. J. lxxvi, 325, 337
Webber, H. J., report lix
Weed, C. M. 290
Weed seeds, effect of sulfuric acid treatment on germination 321
Western New York Horticultural Society lxxxvi, lxxxvii
Wheat-breeding experiments lxvi, lxxi
Whetzel, H. H. lxxxix
Whetzel, H. H., report lxxxi
White, Nathan 169
White, P. J. lvii, 396
White, T. G. 662, 665
White pine blister rust lxxxiv
Whitney, C. C. 169
Williams, C. G. 296, 312
Wilson, C. S. cvii, 163, 165, 169
Wilson, C. S., report cv
Wilson, T. B. 169
Wilson, W. M. clv, 505
Wilson, W. M., report cliv

PAGE
Wilt of ginseng.. lxxxiii
Winchell, Mr. 515
Wing, H. H. ....cxxii, cxxiv, 1, 33, 229
Wing, H. H., report.. cxxi
Wing, L. W. cxvii
Winter-Course in Dairy Industry...............................cxvi, cxcvii
Winter-Course in General Agriculture.........................lvii, cxxv, cxcvi
Winter-Course in Home Economics.........................cxlvii, cxlix, cc
Winter-Course in Horticulture....................................c, cxcix
Winter-Course in Poultry Husbandry..........................cxxvi, cxcviii
Winter-Courses ....xli, cxcvi
Winter-flowering sweet peas.......................................ci, 617
Witter, D. P. 404
Wood in various trees, growth of...................................... lxxviii
Work, Paul cii

Z

Zvolanek, A. C. 619, 621, 622, 623, 631, 633

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